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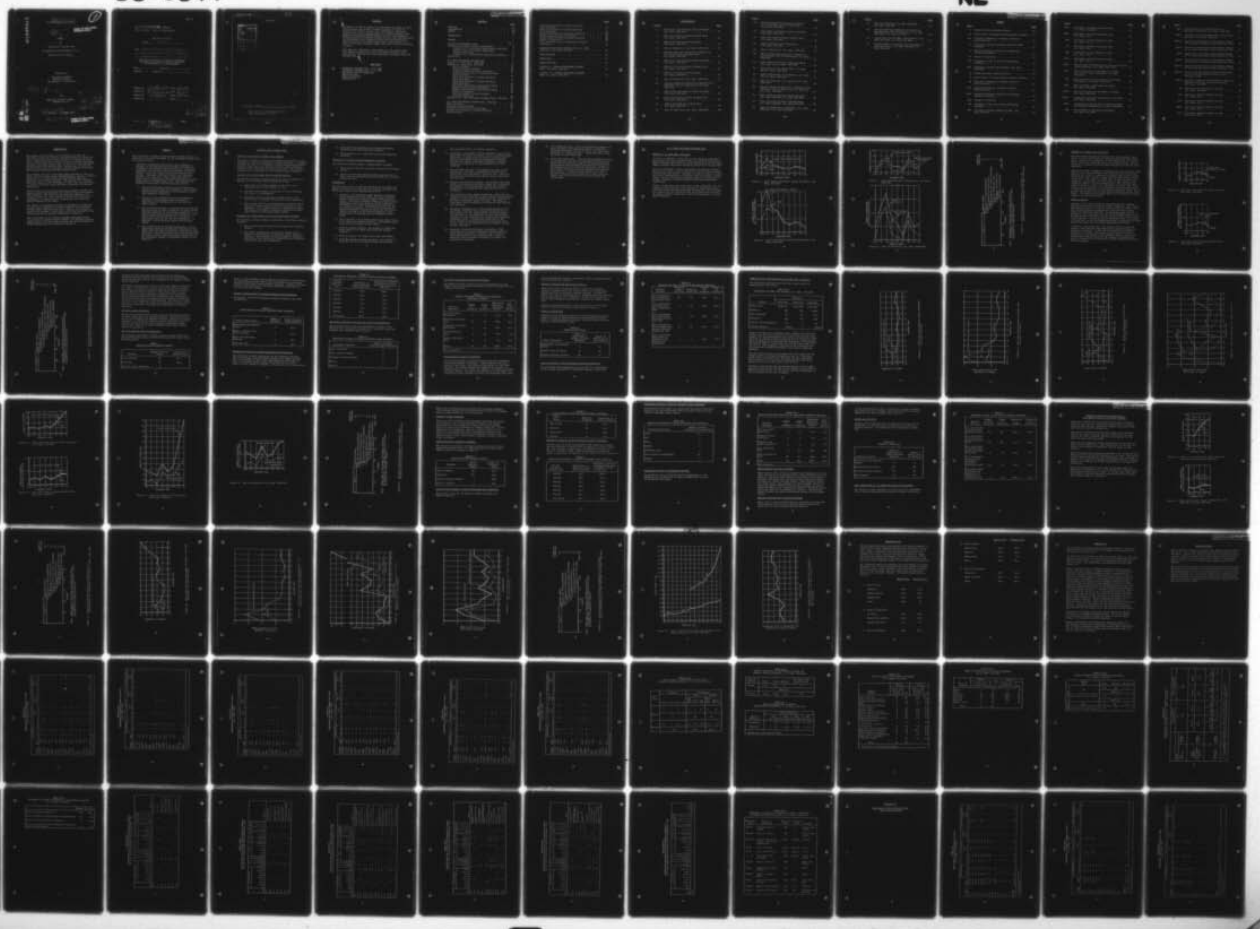

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(6) A STUDY OF HELICOPTER ACCIDENT DATA TO DETERMINE THE FEASIBILITY OF A SURVIVAL ESCAPE SYSTEM

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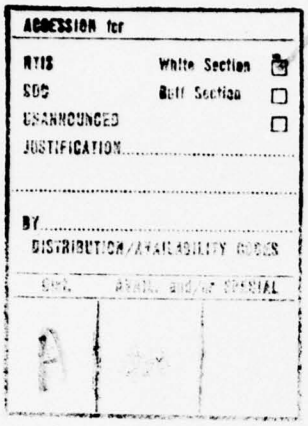

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ABSTRACT

The purpose of these studies is to determine the need for helicopter escape and survival systems designed to reduce the fatality and critical injury rate in helicopter accidents. Reference is made to documentation of a study performed under BuWeps Contract NOW61-0668-C dated 8 October 1962 entitled: "Feasibility Study of Escape Systems for U.S. Navy Helicopters". The referenced study covered all U.S. Navy and Marine helicopter accidents from 1952 through 1960. Special data were reduced from those accidents which resulted in fatal or critical injuries.

This document represents a continuation of the former study and covers U.S. Navy/U.S. Marine helicopter accidents from 1961 through 1965 and U.S. Army helicopter accidents from 1958 through 1965.

KEY WORDS

HELICOPTER ACCIDENT DATA - U.S. ARMY
HELICOPTER ACCIDENT DATA - U.S. NAVY
HELICOPTER ESCAPE FEASIBILITY
ESCAPE CAPSULE
ESCAPE SITUATIONS
CRASH-SAFETY

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

The purpose of this study is to determine the need for helicopter escape and survival systems designed to reduce the rate of fatalities and critical injuries in helicopter accidents. This study covers all U. S. Navy and Marine helicopter accidents from 1961 through 1965 and all U. S. Army helicopter accidents from 1958 through 1965. Conclusions are based on the data from this study combined with the former study which covered Navy accidents from 1952 through 1960.

The accident data for this project were provided by the U. S. Naval Aviation Safety Center (NAVAVNSAFECEN), Norfolk, Virginia, and by the U. S. Army Bureau Aviation Accident Research (USABAAR), Fort Rucker, Alabama. The summary data presented here are based on 2,487 accidents, of which 199 are classified as fatal or critical injury accidents involving 504 occupant fatalities.

The Navy data for this study have been reduced to graphs and tables to match the format of the earlier study under Contract NOw 61-0668-c. The format of the Army data appears to be slightly different. This deviation in style is necessary to accommodate the dissimilarity of operations and reporting methods between the services.

The reports of accidents directly attributable to combat are in many cases fragmentary in content because of the circumstances under which they are made. However, the available reports are included in this study since they represent a significant portion of current operational activities.

The limitations of the details available preclude precise analysis of the accident data; however, the accident patterns emerge clearly and can serve as guides for the development of escape systems and other protective measures.

GENERAL

The prevailing attitude toward helicopter flight safety is presented clearly and concisely in the following excerpt from the previous study:

> "In-flight emergencies from which a safe landing or ditching is not possible have long been recognized as a problem in fixed-wing aircraft operation. Personnel parachutes and ejection seats have provided reasonably effective means of escape from such fixed-wing emergencies. Helicopter pilots, however, have generally relied on the hope that a safe, controlled descent could be made following an in-flight emergency and parachutes have not usually been worn. This attitude has probably been derived from the following factors:
>
> 1. The autorotational capability of the helicopter, permitting power-off, steep gradient, spot landings, instills pilot confidence in the ability to cope with emergency situations.
>
> 2. Mistrust of the effectiveness of the personnel parachute in helicopter escape situations, associated with the proximity of the whirling rotor blades.
>
> 3. The low altitudes flown as compared with fixed-wing operations may be both a cause and an effect of the attitude described in the previous paragraph; i.e., lack of parachutes encourages low flying so as to permit quick landing in the event of trouble; low flying rules out the use of a parachute. In addition, certain missions demand low altitude flight.
>
> 4. The inconvenience of wearing a parachute. A few successful parachute escapes have been made by test pilots from helicopters disabled at relatively high altitudes. None are known to have been accomplished by service pilots under operational conditions, nor are successful escapes by passengers known to have occurred."

SURVIVAL REQUIREMENTS STUDY

CRITERIA FOR JUDGING SURVIVAL REQUIREMENTS

Helicopter accident histories were studied individually to determine the survival requirements in each situation. A judgment was made for each fatal accident to determine whether occupant survival could have been achieved and what safety provision would have been necessary to achieve survival. The following criteria were established to aid in making these judgments.

Criteria for an In-Flight Escape System Situation

All of the following criteria must be met for an accident to qualify as an in-flight escape system situation:

1. There must be a clear warning to the pilot of an impending loss of lift and/or control.

2. The pilot must retain the ability to react following the onset of the emergency.

3. Helicopter terrain clearance altitude must be 100 feet or more at warning of the onset of the emergency.

4. The descent must be uncontrolled with resultant severe impact, incurring fatal or critical injuries to the occupants. It is assumed that in a controlled descent the pilot would normally choose to autorotate rather than actuate an in-flight escape system.

Criteria for a Survivable, Non-Escape Situation Emergency

The following criteria define a survivable, non-escape situation accident:

1. The situation does not meet all criteria for in-flight escape.

2. The impact attitude and velocity are judged to be within the capabilities of practical impact protection features. The retention of living space in occupied sections and the existence of survivors were considered where other data were unavailable.

3. Provisions for helicopter and occupant emergency flotation would have permitted survival.

4. The prevention of a crash fire would have permitted survival.

Criteria for a Nonsurvivable Emergency Situation

The following criteria define a nonsurvivable accident:

1. The situation does not meet all criteria for in-flight escape.

2. Impact is such that improved safety features for impact, fire, or emergency flotation would not have permitted survival.

DEFINITIONS

The following terms are defined according to the intent and manner of their use in this report, to avoid confusion with other usage where their meanings may differ:

1. Accident - An unforeseen event wherein a helicopter being operated with the intent for flight sustains damage requiring a specific number of manhours for repair. The repair manhours differ for various model helicopters and can be found in OPNAV Instruction P3750.6E for U.S. Navy helicopters and AR385-40 for U.S. Army helicopters. It should be noted that although helicopters damaged in combat are not classified as accidents in the above regulations, such occurrences are included for the purposes of this study.

2. Fatal accident - An accident wherein the worst injury is at least one occupant fatality. Nonoccupant fatalities are not included in this study.

3. Critical injury accident - An accident in which the worst injury is at least one critically injured occupant.

4. Critical injury - An injury which may cause death.

5. In-flight escape situation accident - An accident in which the use of an in-flight escape system could

have precluded fatal or critical injuries.

6. Survivable, non-escape situation accident - An accident which does not meet the criteria for an in-flight escape system but in which fatal or critical injuries could have been precluded by the incorporation of safety features for impact protection, emergency flotation, crash fire protection, or any combination of these features.

7. Nonsurvivable accident - An accident in which circumstances are such that no protective features could conceivably have precluded a fatality; i.e., the accident involved extremely high impact forces, explosion, and the like.

8. Unknown survivability accident - An accident involving fatal or critical injuries where there are no survivors or witnesses or where accident reports are otherwise insufficient to determine the survivability of the occupants.

9. Fire protection plus impact protection - This form of safety protection applies to hard landings and survivable crashes in which fire and fatalities occur accompanied by known or probable impact injuries. The injuries from impact tend to prevent the occupants from escaping from the fire.

10. Emergency flotation only - This safety feature covers successful ditchings which produce fatalities due to such factors as: (1) rapid sinking of the helicopter, (2) inability of the occupants to leave the aircraft quickly, and (3) difficulty in releasing and launching inflatable rafts. In many such cases, even a few extra seconds of aircraft flotation could have saved lives. Each of the accidents in this category had one or more survivors.

11. Emergency flotation plus impact protection - This category refers to hard ditching or water crashes in which impact injuries to occupants were believed to have contributed to their drowning due to loss of mobility, being stunned to inaction, or similar incapacitating injuries.

12. Fire protection only - This safety mechanism applies to those accidents involving mild impact in which the occupants apparently sustain little or no injury until the start of a postcrash fire. There were one or more survivors in each such case.

13. Impact protection only - This survival mechanism applies to crashes where the use of load-limiting devices, improved bodily restraints, and safety-oriented occupant surroundings could probably have prevented fatalities. An example would be a moderate-impact-type accident in which there are several injured survivors and perhaps one fatality. It appears very probable that such a fatality could have been prevented as long as the occupied cabin area retained its essential shape and living space.

U. S. NAVY HELICOPTER ACCIDENT DATA

INITIAL U. S. NAVY DATA, 1952-1960

In order to establish a baseline for the analysis performed in this study, data were extracted from the previous study under BuWeps Contract NOw 61-0668-c, which represents U. S. Navy helicopter accident experience during the period 1952 through 1960.

As shown in Figures 1 and 2, the number and the rate of fatal and critical injury accidents exhibited a significant downward trend during this period. However, as shown in Figures 3 and 4, the annual distribution of fatalities does not follow a uniform trend. This is attributed to greater numbers of occupants in several accidents at various points during the period under examination.

Figure 5 summarizes the initial data study indicating that 55.8 percent of the fatalities (77) occurred in emergencies where in-flight escape was the only means of survival. An additional 24.7 percent of the fatalities (36) could have been prevented by improved impact protection, crash fire prevention, and emergency flotation.

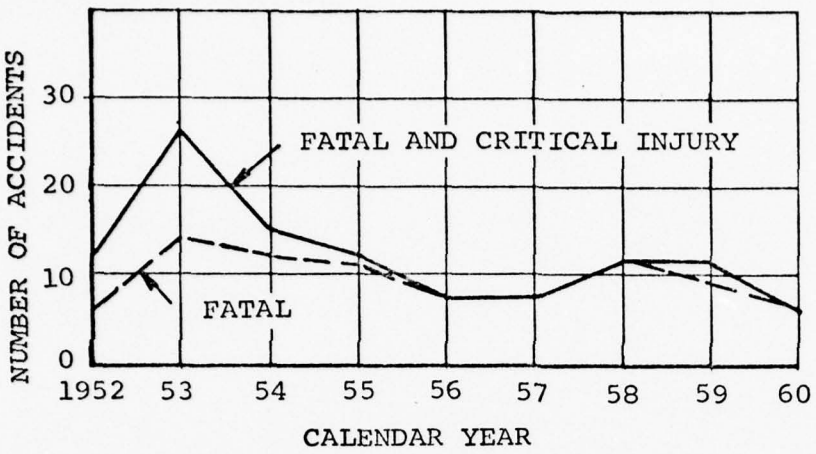


Figure 1. Total Fatal and Critical Injury Accidents, U.S. Navy, 1952-1960

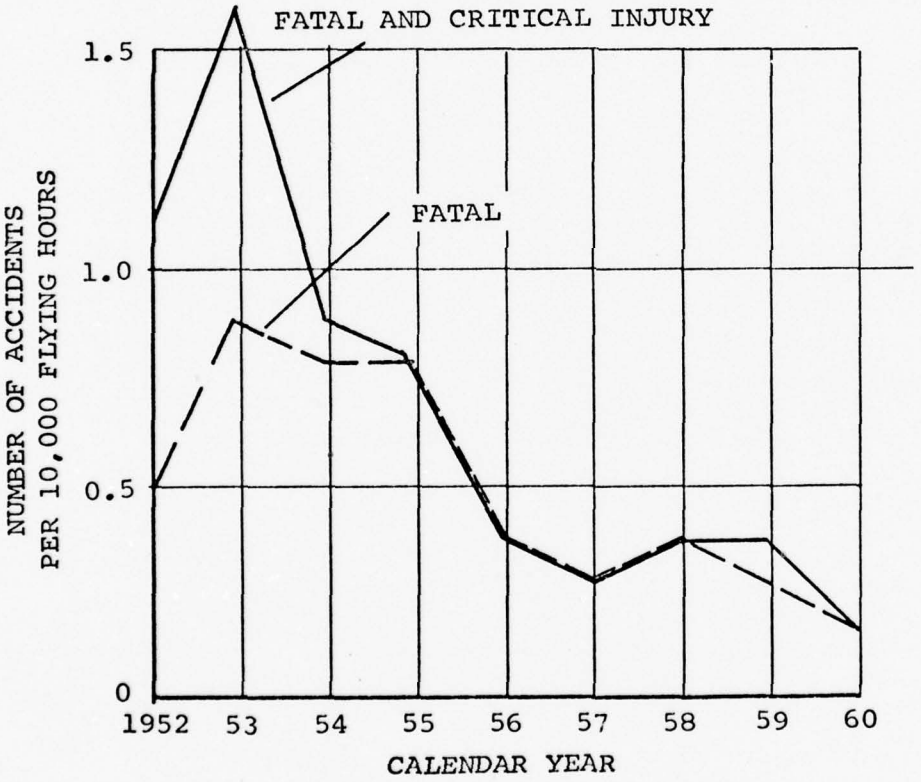


Figure 2. Fatal and Critical Injury Accident Rate, U.S. Navy, 1952-1960

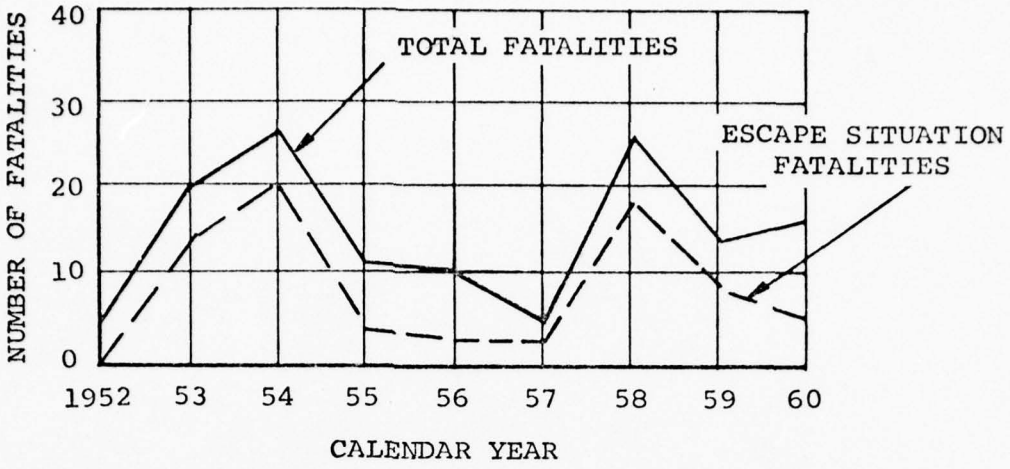


Figure 3. Annual Distribution of Fatalities, U.S. Navy, 1952-1960

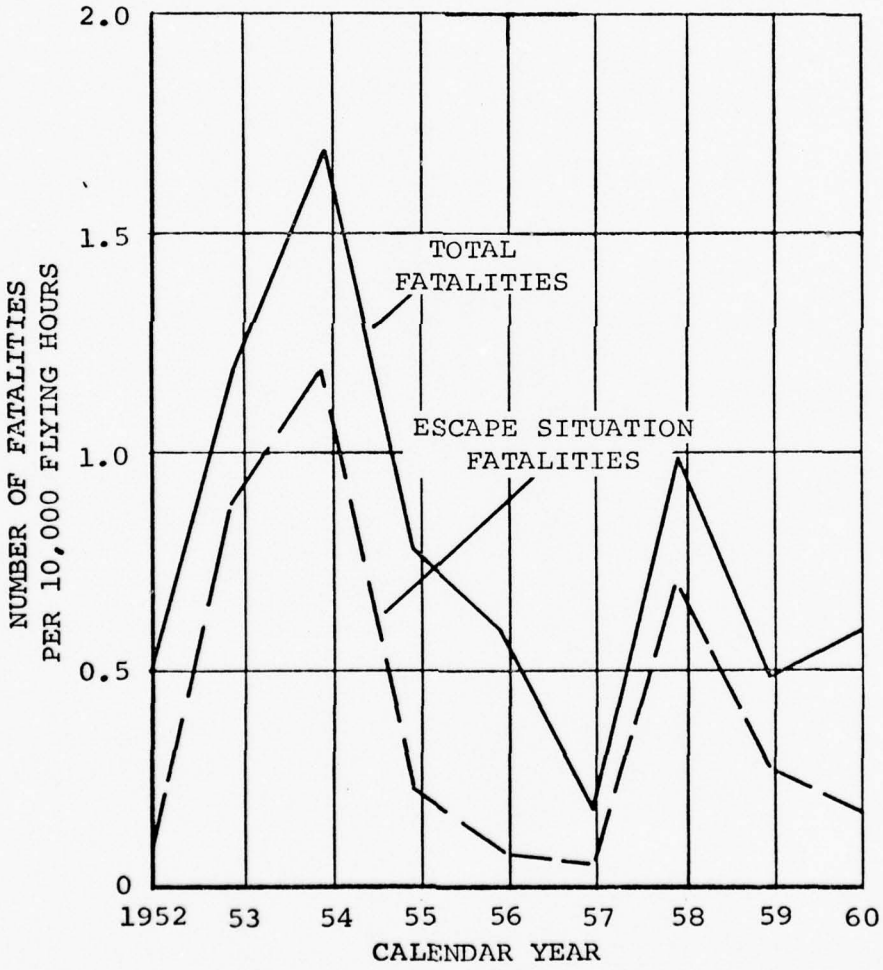
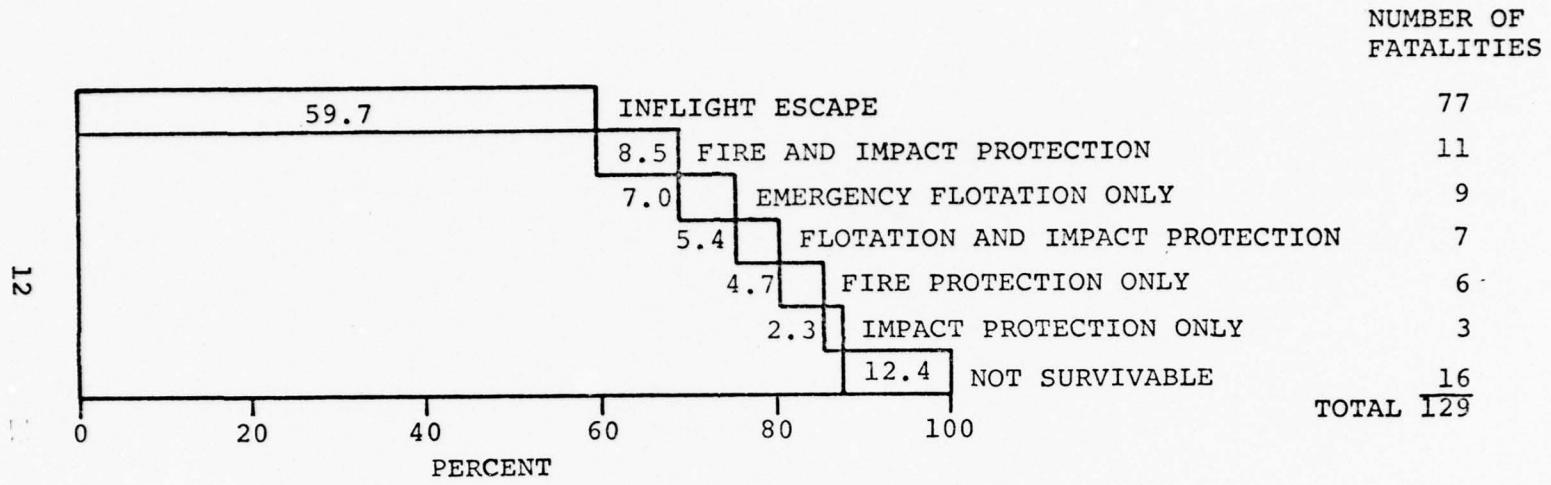


Figure 4. Rate of Fatalities, U.S. Navy, 1952-1960



NOTE: THERE WERE 3 ADDITIONAL ACCIDENTS INVOLVING 9 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 5. Survival Mechanism Potential as Applied to 65 Accidents with 129 Fatalities, U.S. Navy, 1952-1960

UPDATED U. S. NAVY DATA, 1961-1965

The helicopter accident data during this 5-year period, while the U. S. Navy and Marines were accumulating 2,012,002 flying hours, comprise 337 accidents, 50 fatal accidents, 137 fatalities, 1 critical injury accident, 3 critical injuries, and an additional 3 critical injuries which occurred in 2 of the fatal accidents.

Figures 6 through 9 depict the quantity and rate trend for fatal and critical injury accidents and fatalities during the 1961-1965 period. Figure 6 indicates an upward trend in the number of accidents while Figure 7 shows that the rate trend is relatively flat. The number of fatalities as shown in Figure 8 is irregular, and for the last three years of the study is substantially higher than in previous years. The fatality rate trend as shown in Figure 9 is similarly irregular. The irregularity and the increase in the fatalities are probably related to substantial increases in flying hours (exposure level) and to greater operational use of newer model helicopters during these years. See Tables XVIII through XXII for the detailed accident summaries by helicopter model.

Fatal Accidents

Analysis of the fatal accidents and fatalities for survival requirements resulted in the bar chart, Figure 10. This analysis indicates that 32.1 percent of the fatalities (44) in this data period occurred in emergencies where in-flight escape would have permitted survival. It should be noted that 12.4 percent of the fatalities (17) are in the UNKNOWN category, due to insufficient information in the accident reports for a survival judgment. In most of these cases there were no survivors or witnesses. It can be hypothesized that a percentage of these fatalities would meet the escape requirements criteria.

A number of the fatalities, 14.6 percent or 20, are in the nonsurvivable category since they do not meet the escape requirements criteria. In most of these cases the helicopter collided with a hill, with wires, or with other aircraft; according to information in the accident reports, the escape requirements criteria were not met because of insufficient ground clearance or the inability to react following the onset of the emergency.

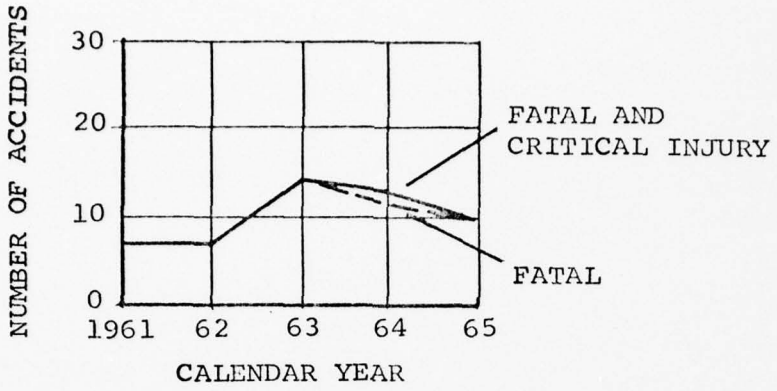


Figure 6. Total Fatal and Critical Injury Accidents, U.S. Navy, 1961-1965

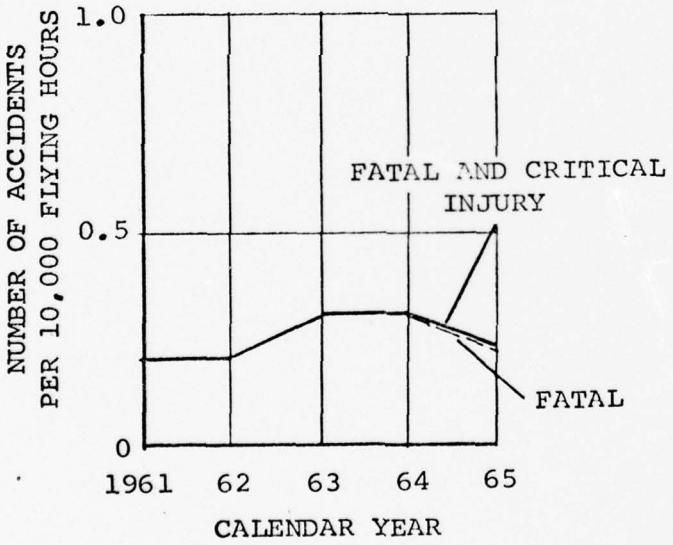


Figure 7. Fatal and Critical Injury Accident Rate, U.S. Navy, 1961-1965

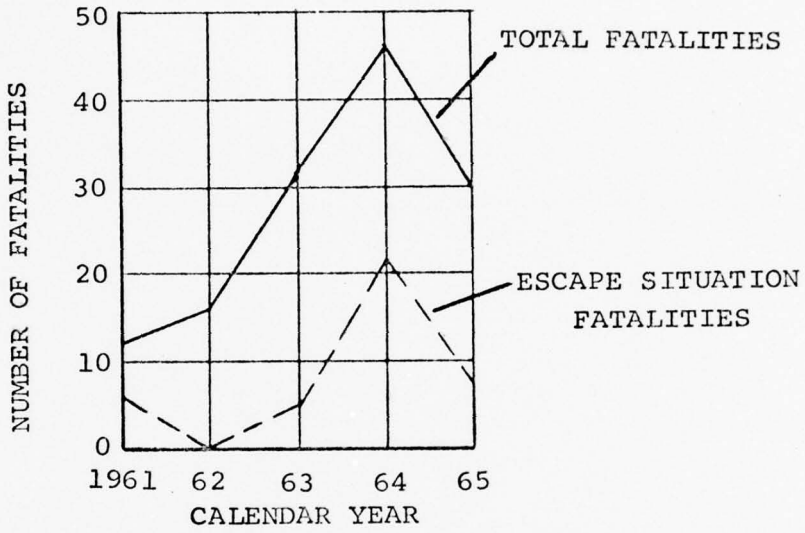


Figure 8. Annual Distribution of Fatalities, U.S. Navy, 1961-1965

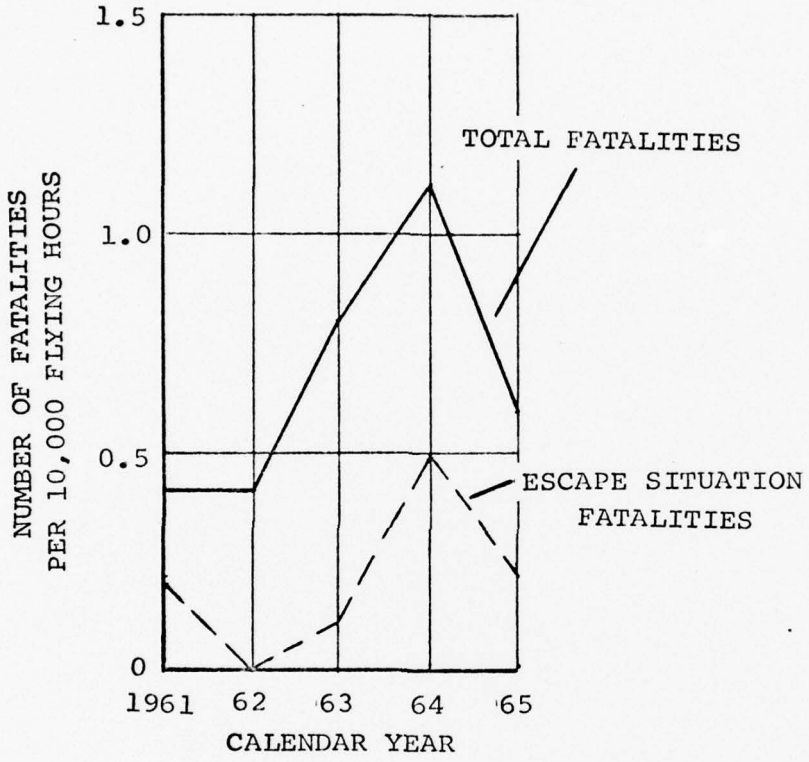
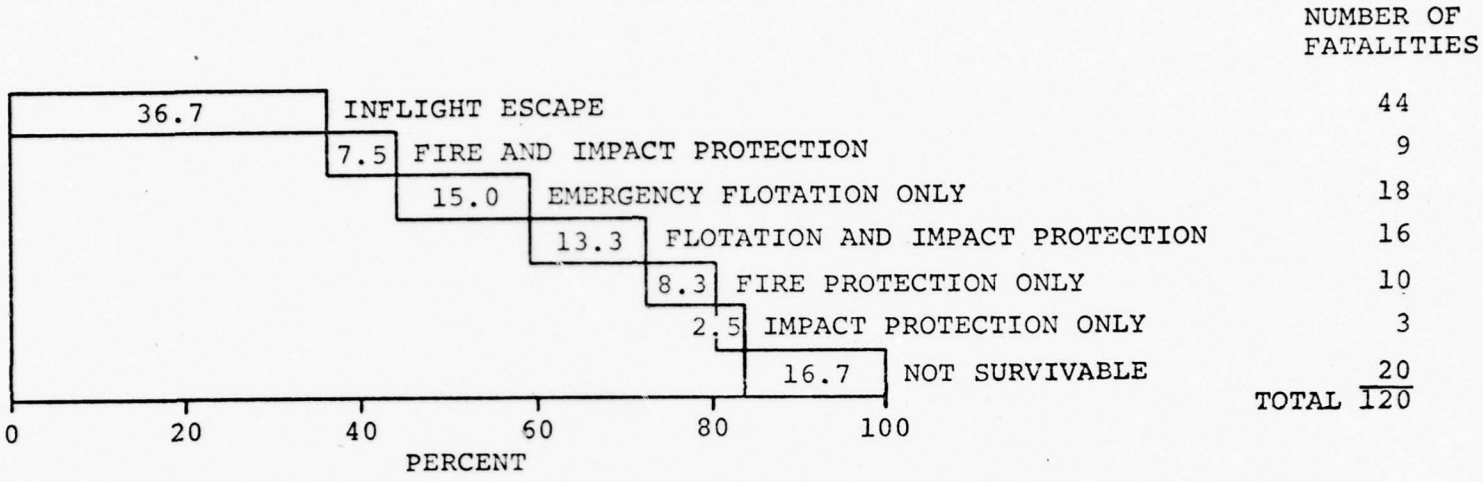


Figure 9. Rate of Fatalities, U.S. Navy, 1961-1965



NOTE: THERE WERE 5 ADDITIONAL ACCIDENTS INVOLVING 17 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 10. Survival Mechanism Potential as Applied to 45 Accidents with 120 Fatalities, U.S. Navy, 1961-1965

Analysis of the survivable non-escape situation accidents revealed that 40.9 percent of the fatalities (56) were candidates for survival through the incorporation of improved crash safety features.

Particular attention was given to situations where autorotation was used in the emergency. These cases were evaluated using the escape requirements criteria with the addition of environmental factors such as location, time of day, and the like. There were three such situations involving seven fatalities. One of these accidents with four fatalities was considered an in-flight escape situation because of maneuvering difficulties following the initiation of autorotation. The other two cases involving three fatalities were not considered in-flight escape situations since they were below the requirement for ground clearance.

Critical Injury Accidents

During the 1961-1965 study period there was one critical injury accident involving three critical injuries. This accident was at very low altitude and therefore did not constitute an escape situation. It should be noted that three additional critical injuries occurred in two fatal accidents which were escape situations. Details of these accidents can be found in the tables in Appendix I.

In-Flight Escape Situation Accidents

The emergency situations in which an escape system could have permitted survival during the 1961-1965 period are shown in the following table.

TABLE I
ESCAPE SITUATION ACCIDENT SUMMARY

Category	Escape Situation Number	Percent of Category Total
Fatal accidents	12	24
Fatalities	44	32.1
Critical injury accidents	0	-

Refer to Tables XXXIII through XXXVIII in Appendix I for details. It should be noted that four of the situations, or 33 percent, involved later-model turbine-powered aircraft. Figures 6 through 9 depict the trend curves for fatal accidents and fatalities for the 1961-1965 period.

Primary Cause Factors in Escape Situation Fatal Accidents

The primary causes of the escape situation accidents are shown in Table II.

TABLE II
CAUSE FACTORS OF ESCAPE SITUATION FATAL ACCIDENTS

Primary Cause Factor	Number of Accidents	Escape Situation Fatal Accidents
Maintenance and material failure	9	75.0
Midair collision with other aircraft	1	8.3
Pilot disorientation (vertigo)	1	8.3
In-flight fire	1	8.3

Helicopter Altitude in Escape Situation Fatal Accidents

The altitudes at which recognition of the emergency occurred for the 12 escape situation fatal accidents are shown in Table III. The altitude in each case also represents the height at which an in-flight escape system would have been actuated. Refer to Table XXXIX in Appendix I for details of the occurrences.

TABLE III
ALTITUDE OF EMERGENCY IN ESCAPE SITUATION FATAL ACCIDENTS

Terrain Clearance Altitude Feet	Percentage of Escape Situation Fatal Accidents	Cumulative Percentage of Emergencies Above Reference Altitude of 100 Feet
100-199	8.3	100.0
200-299	25.0	91.7
300-399	8.3	66.7
400-499	8.3	58.4
500-599	0.0	50.1
600-699	16.7	50.1
700 and up	33.4	33.4

Helicopter Attitude in Escape Situation Fatal Accidents

The following table shows the approximate attitude of the helicopter at the estimated moment when the pilot would have actuated the in-flight escape system.

TABLE IV
HELICOPTER ATTITUDE IN ESCAPE SITUATION FATAL ACCIDENTS

Helicopter Attitude	Number of Escape Situation Fatal Accidents
Level, free fall	2
Level, partial control	2
Spinning or spiral descent	5
Nose up	2
Unknown	1

Survivable Non-Escape Situation Accidents

The potential value of various survival mechanisms in non-escape situation accidents is shown in Table V in terms of preventing fatalities.

TABLE V
SURVIVAL MECHANISM POTENTIAL IN NON-ESCAPE SITUATION ACCIDENTS

Survival Mechanism	Number of Accidents	Number of Fatalities	Non-Escape Situation Fatalities Percent	All Fatalities Percent*
Fire and impact protection	3	9	16.0	6.6
Emergency flotation only	11	18	32.2	13.1
Flotation and impact protection	9	16	28.6	11.7
Fire protection only	4	10	17.8	7.3
Impact protection only	2	3	5.4	2.2
Total	29	56	100.0	40.9

*137 fatalities

Nonsurvivable Situation Accidents

Five fatal accidents involving 20 fatalities were considered to be nonsurvivable situations. These accidents were due mainly to collisions with terrain, with wires, or with other aircraft, and either occurred at altitudes too low for in-flight escape, or the pilots were judged to be unable to effect in-flight escape. One victim was struck by a rotor blade, and, although the other occupant survived, the occurrence was judged

to be nonsurvivable since no reasonable impact protection could have prevented the fatality.

Unknown Survivability Situation Accidents

There were 5 fatal accidents with 17 fatalities in which survival judgments could not be made because of insufficient information in the available accident reports. In these 4 cases there were no survivors and no witnesses and parts of only one of the aircraft were recovered. It should be noted that one of these accidents involved two aircraft in a midair collision.

It can be hypothesized that a percentage of these fatalities would have met the in-flight escape system criteria.

Causes of Fatalities

Analysis of the accident reports in the 1961-1965 period indicates that most of the fatalities are from drowning, severe burns, or multiple extreme injuries. The fatalities are categorized in the following table.

TABLE VI
CAUSES OF FATALITIES

Cause of Fatality	Number of Fatalities in Escape Situation Accidents	Number of Fatalities in All Accidents
Drowned/lost and presumed drowned	6	55
Carbonization and burns	9	27
Multiple extreme injuries	29	55

Fire Involvement in All Helicopter Occupant Fatalities

The following table summarizes all postcrash fire involvement in the various categories of helicopter occupant fatalities.

TABLE VII

INCIDENCE OF FIRE IN ALL FATAL HELICOPTER ACCIDENTS

Accident Category	Number of Fatal Accidents	Number of Fatalities	Percent of Category	Percent of All Fatalities
Fire involvement in all occupant fatalities (137)	21	76	55.5	55.5
Fire involvement in escape situation fatalities (44)	7	32	72.8	23.4
Fire involvement in nonsurvivable situation fatalities (20)	3	17	85.0	12.4
Fire involvement in survivable non-escape situation fatalities (56)	10	23	41.2	16.8
Fire involvement fatalities in accidents with unknown survivability	1	4	23.5	2.9

COMPOSITE U.S. NAVY HELICOPTER ACCIDENT DATA, 1952-1965

The helicopter accident data for this 14 year period is summarized in Table VIII.

TABLE VIII
HELICOPTER ACCIDENT DATA SUMMARY, U.S. NAVY, 1952-1965

Factor	Timespan		
	1952-1960	1961-1965	1952-1965
Flying hours	1,821,657	2,012,002	3,833,659
Accidents	913	337	1,250
Fatal accidents	87	50	137
Fatalities	138	137	275
Critical injury accidents	20	1	21
Critical injuries	24 (est)	3	27 (est)

Analysis of these data indicates that, although the 1961-1965 study period is only 55 percent as long as the initial study period, U.S. Navy helicopters were flown 10 percent more hours, had only 36 percent as many accidents, had 57 percent as many fatal accidents, but had nearly the same number of fatalities. The average number of fatalities per accident has risen from 1.6 to 2.7; this increase is believed to be associated with the wider use of larger helicopters with greater passenger capacity.

The fatal and critical injury number and rate trends for the 14-year period are shown in Figures 11 and 12. From these trend curves it appears that the number of fatal accidents has leveled off at an average of approximately 9 per year, while the rate is at the level of 0.2 to 0.3.

Figures 13 and 14 show the annual distribution of the number and rate of fatalities for the 14-year period, while Figure 15 shows the applicability of the various survival mechanisms to the fatalities for the same timespan.

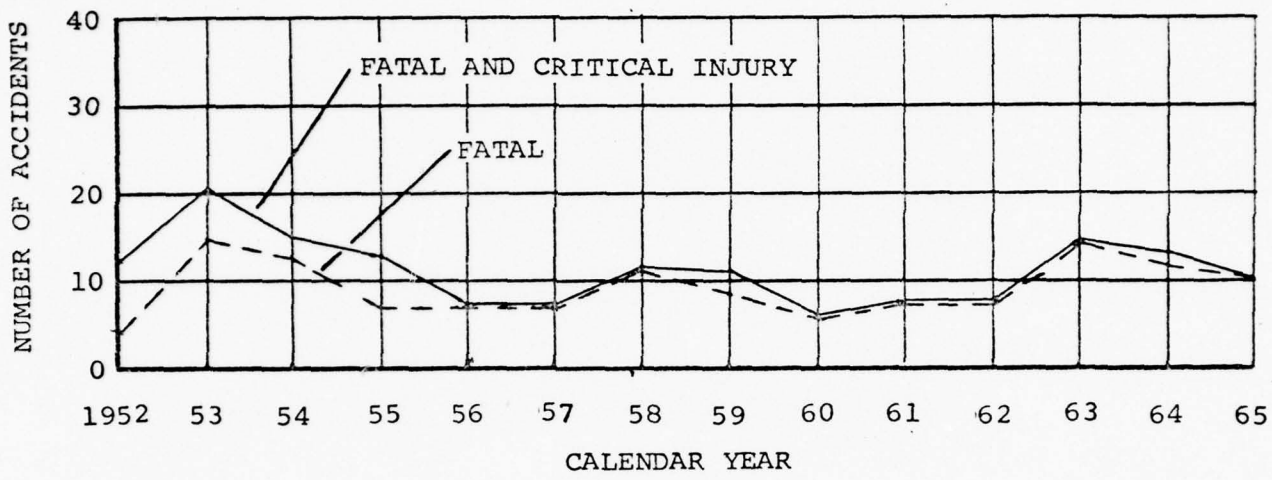


Figure 11. Total Fatal and Critical Injury Accidents, U.S. Navy, 1952-1965

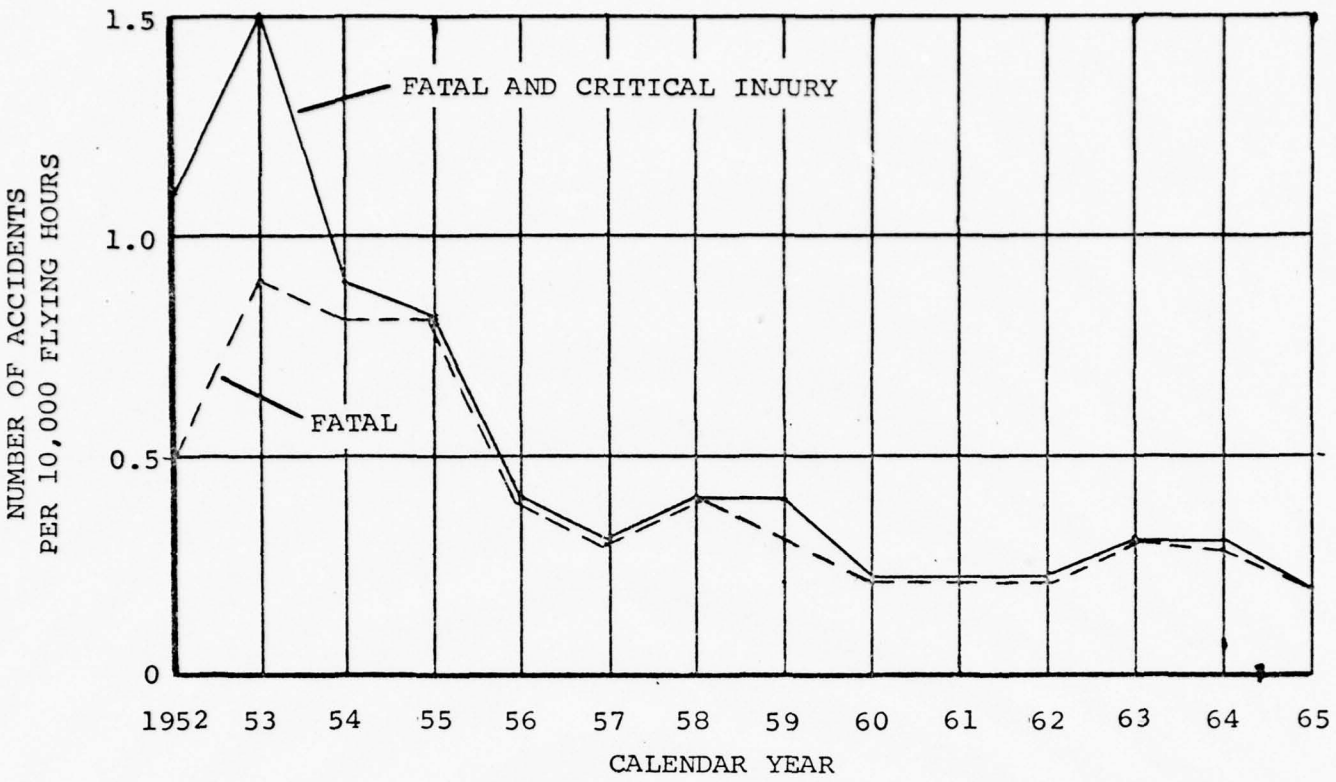


Figure 12. Fatal and Critical Injury Accident Rate, U.S. Navy, 1952-1965

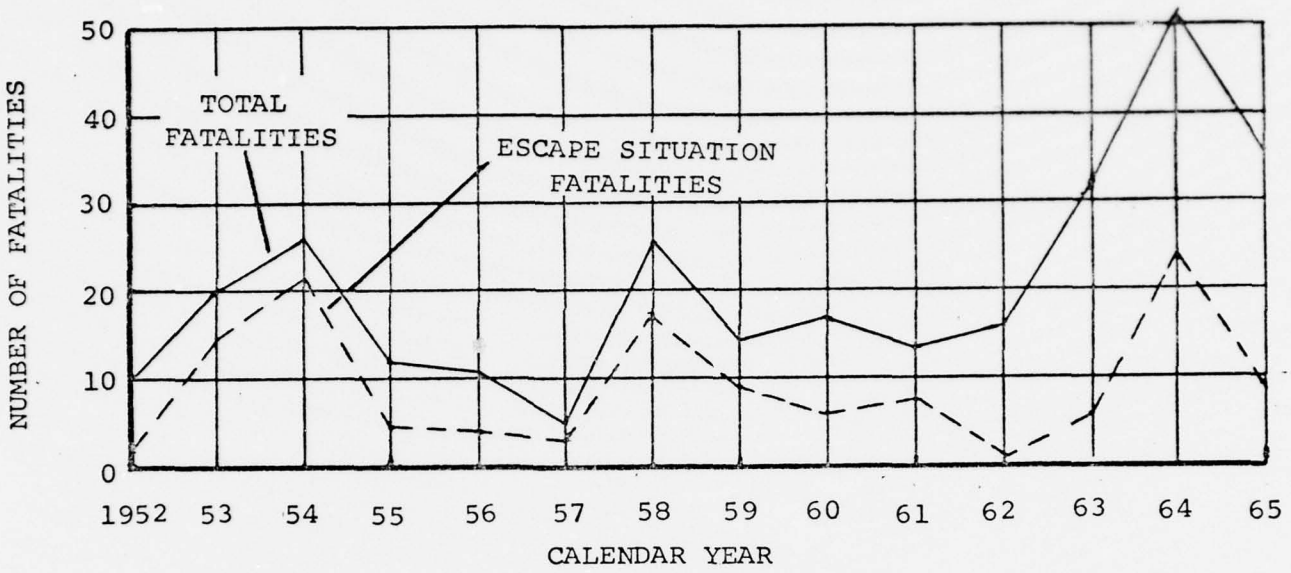


Figure 13. Annual Distribution of Fatalities, U.S. Navy, 1952-1965

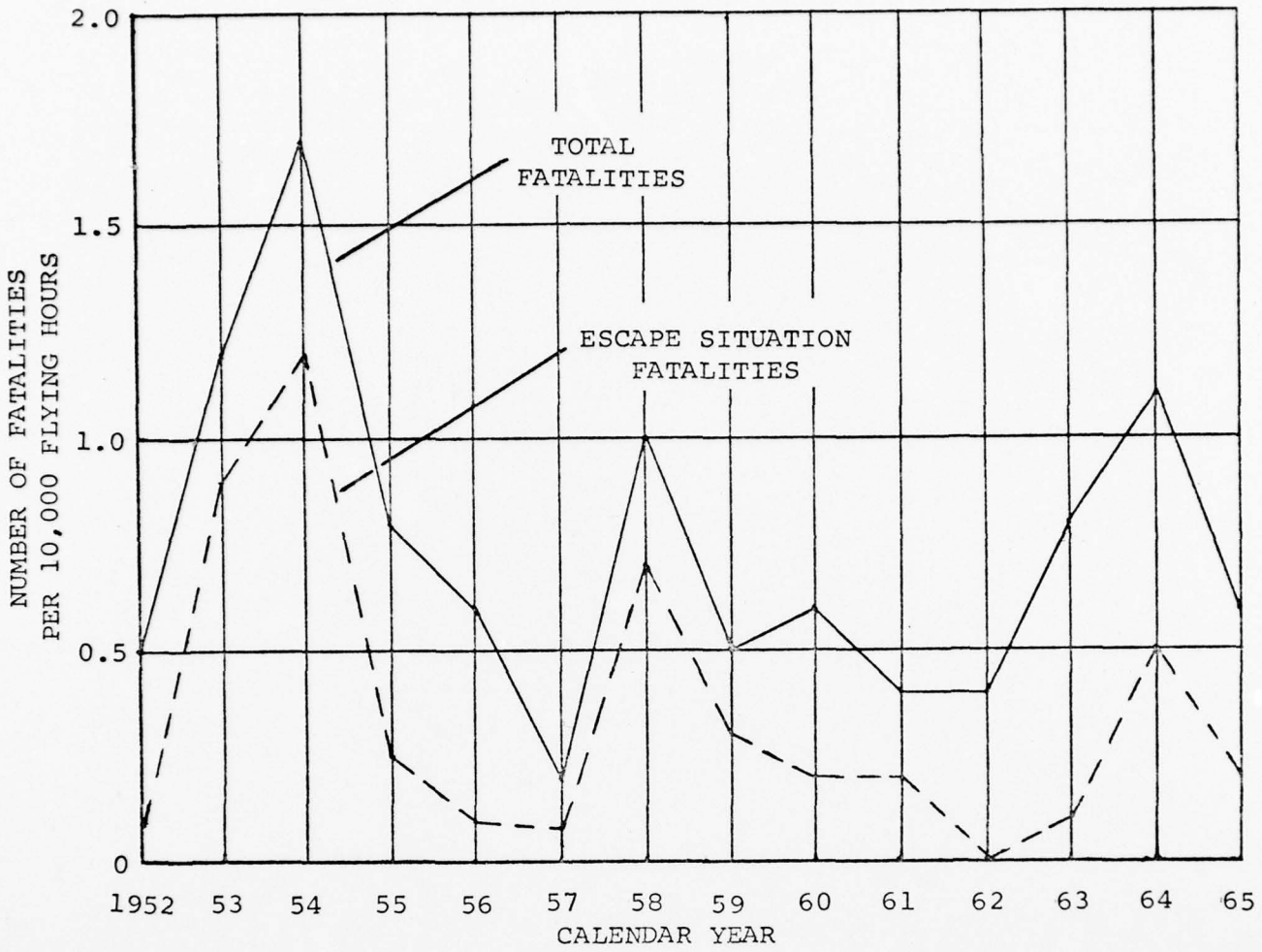
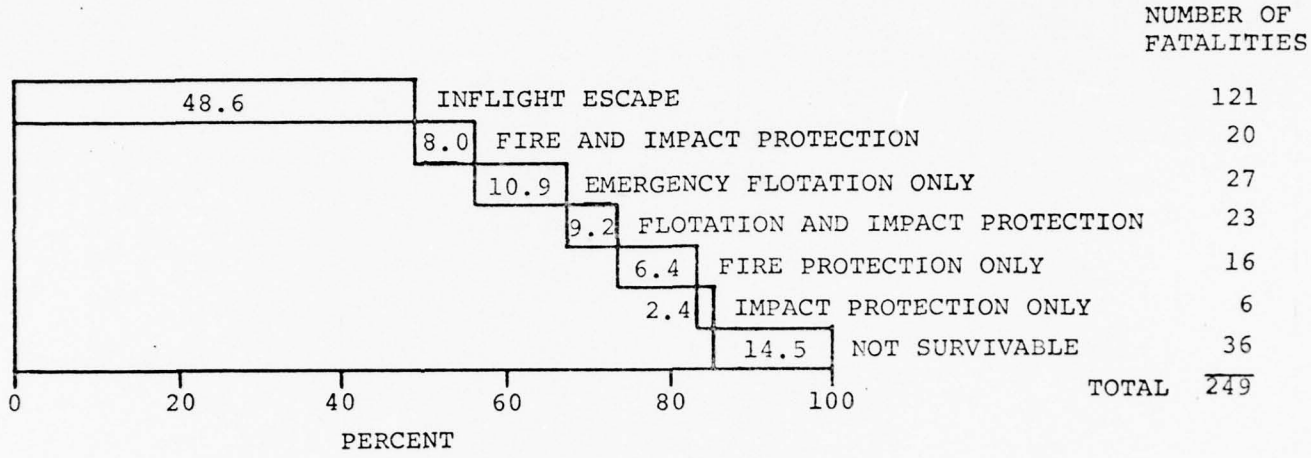


Figure 14. Rate of Fatalities, U.S. Navy, 1952-1965



NOTE: THERE WERE 8 ADDITIONAL ACCIDENTS INVOLVING 26 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 15. Survival Mechanism Potential as Applied to 110 Accidents with 249 Fatalities, U.S. Navy, 1952-1965

U.S. ARMY HELICOPTER ACCIDENT DATA, 1958-1965

The helicopter accident data during this 8-year period, while the U.S. Army was accumulating 5,604,133 flying hours, comprise 2,150 accidents, 143 fatal accidents, 367 fatalities, 5 critical injury accidents, 6 critical injuries, and an additional 3 critical injuries which occurred in 2 of the fatal accidents.

The reduction of these data to quantity and rate trends produced Figures 16 through 19, which show increasing accident numbers and rates. These increases are probably related to the steadily rising operational use of newer model helicopters.

FATAL ACCIDENTS

The analysis of the fatal accidents and fatalities relative to survival requirements resulted in the bar graph, Figure 20. This analysis shows that 42.8 percent of the fatalities (157) in this data period occurred in emergencies where in-flight escape could have resulted in survival. It should be noted that 12.0 percent of the fatalities (44) are in the unknown category because of insufficient information to make a survival requirements judgment. In most of these cases there were no witnesses or survivors. It can be hypothesized, however, that a percentage of these accidents would meet the escape requirements criteria.

An additional 16.9 percent of the fatalities (62) are in the nonsurvivable category. In most of these cases, the helicopter collided with a hill, with wires, or with other aircraft and did not meet the escape situation criteria because of insufficient ground clearance or the inability of the pilot to react following the onset of the emergency.

Analysis of the survivable non-escape situation accidents revealed that 28.3 percent of the fatalities (104) were candidates for survival through the incorporation of improved crash safety features.

One of the criteria used to determine the feasibility of survival through actuation of an escape system was whether the aircraft made an uncontrolled descent with resultant severe impact, incurring fatal or critical injuries to the occupants. It is assumed that a pilot would normally elect to autorotate if this choice were available to him, considering, of course, the terrain, the weather conditions, and the time of day.

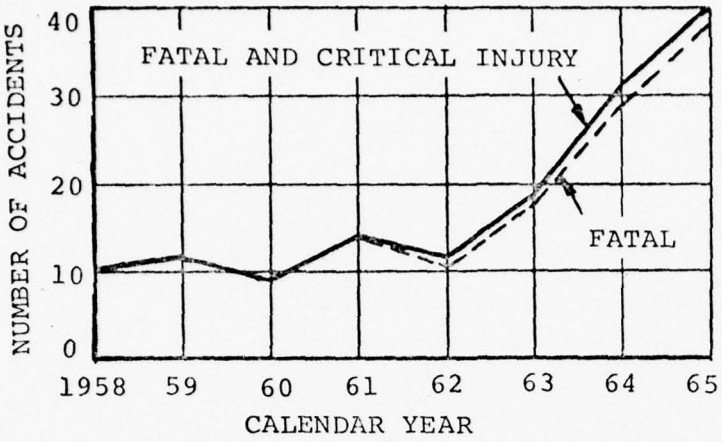


Figure 16. Total Fatal and Critical Injury Accidents, U.S. Army, 1958-1965

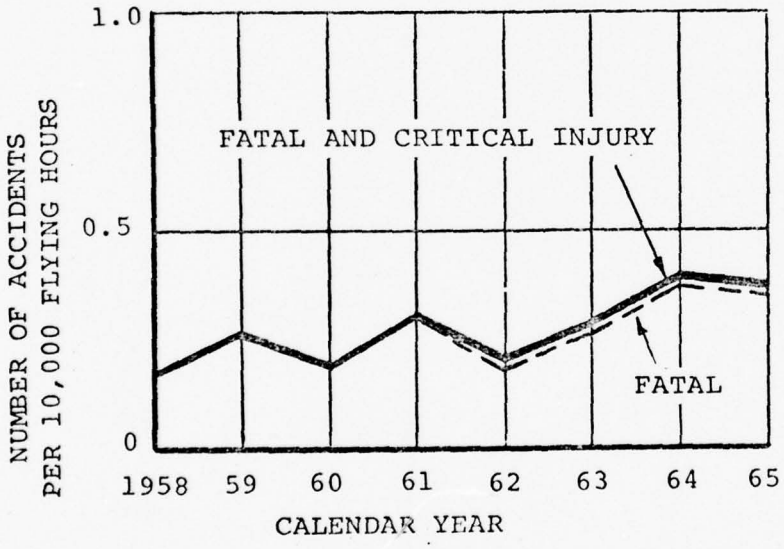


Figure 17. Fatal and Critical Injury Accident Rate, U.S. Army, 1958-1965

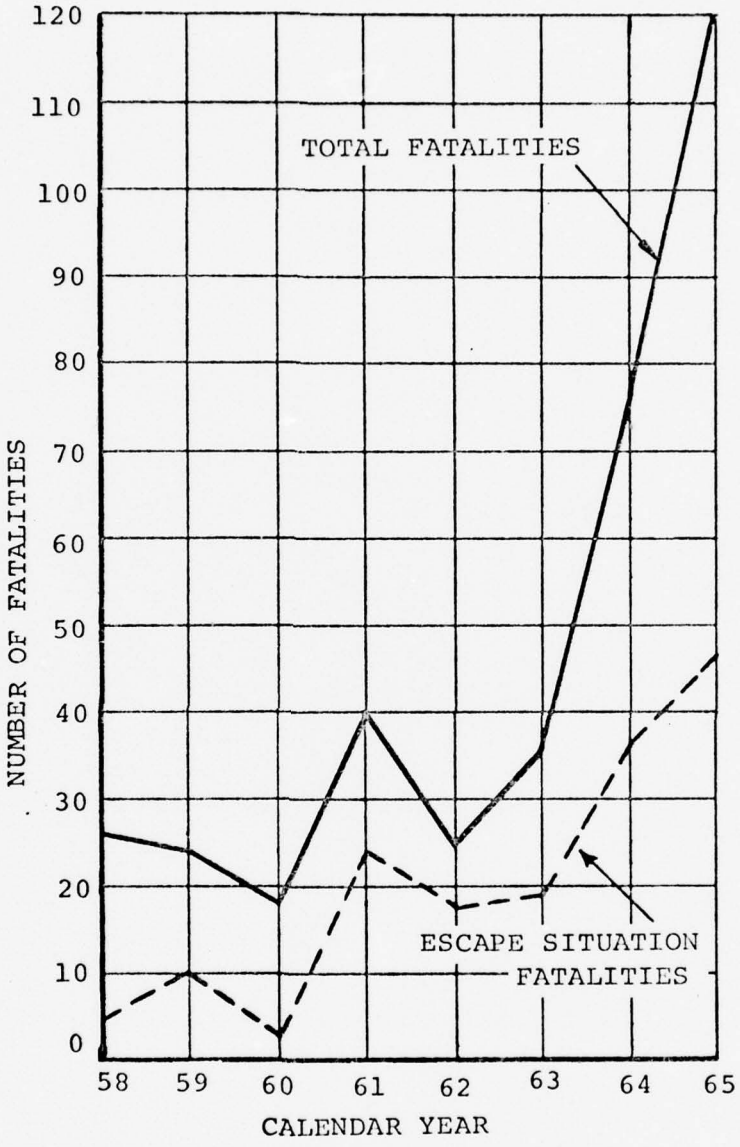


Figure 18. Annual Distribution of Fatalities, U.S. Army, 1958-1965

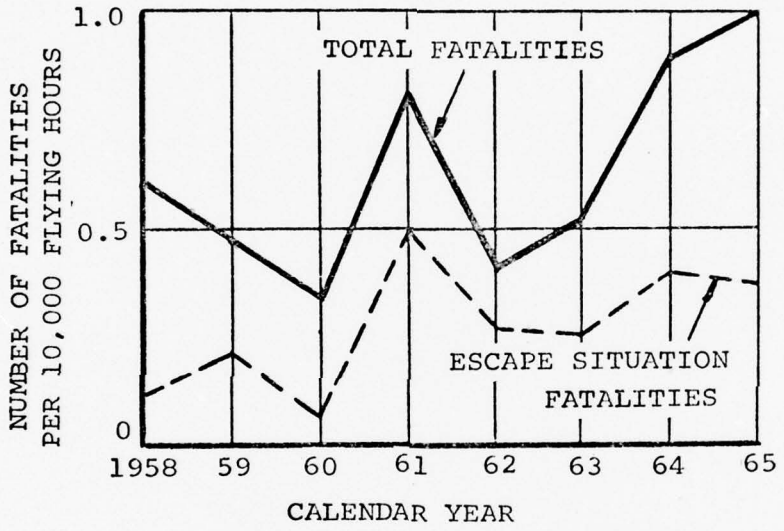
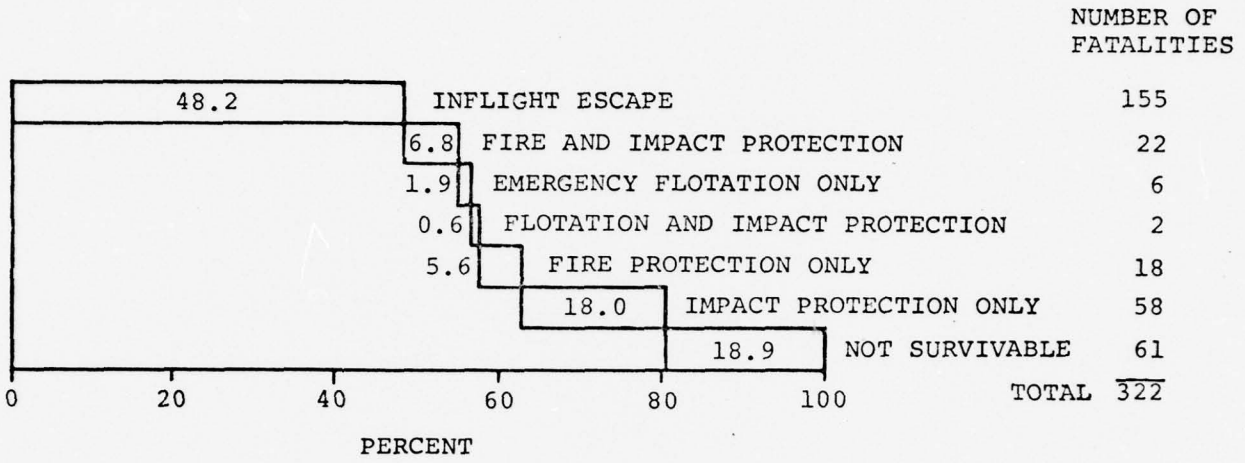


Figure 19. Rate of Fatalities, U.S. Army, 1958-1965



NOTE: THERE WERE 22 ADDITIONAL ACCIDENTS INVOLVING 45 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 20. Survival Mechanism Potential as Applied to 121 Accidents with 322 Fatalities, U.S. Army, 1958-1965

There were 3 attempted autorotations from altitudes adequate for in-flight escape (150 to 200 feet) which failed for environmental reasons, resulting in 20 fatalities.

CRITICAL INJURY ACCIDENTS

There were five critical injury accidents involving six critical injuries. Two of these accidents resulted from combat activities; one is considered an escape situation accident, while the other was a candidate for impact protection. Of the remaining three accidents, only one critical injury was not considered a candidate for impact protection because of the extreme impact forces involved. Two additional critical injuries resulted from a fatal escape situation accident involving eight fatalities.

IN-FLIGHT ESCAPE SITUATION ACCIDENTS

The emergency situations in which an escape system could have permitted survival during the 1958-1965 period of Army helicopter accidents are shown in Table IX.

TABLE IX
ESCAPE SITUATION ACCIDENT SUMMARY

Category	Escape Situation Number	Percent of Category Total
Fatal accidents	46	32.2
Fatalities	157	42.8
Critical injury accidents	1	20.0
Critical injuries	1	16.7

PRIMARY CAUSE FACTORS IN ESCAPE SITUATION FATAL ACCIDENTS

The primary causes of the escape situation accidents are shown in Table X.

TABLE X

CAUSE FACTORS OF ESCAPE SITUATION FATAL ACCIDENTS

Primary Cause Factor	Number of Accidents	Percentage of Fatal Accidents
Operational	17	37.0
Material	19	41.3
Maintenance	7	15.2
Unknown	3	6.5

HELICOPTER ALTITUDE IN ESCAPE SITUATION FATAL ACCIDENTS

The altitudes at which recognition of the emergency occurred for the 46 escape situation fatal accidents are shown in Table XI. The altitude in each case also represents the height at which an in-flight escape system would have been actuated. Refer to Table LXVI in Appendix II for details of the occurrences.

TABLE XI

ALTITUDE OF EMERGENCY IN ESCAPE SITUATION FATAL ACCIDENTS

Terrain Clearance Altitude Feet	Percentage of Escape Situation Fatal Accidents	Cumulative Percentage of Emergencies above Reference Altitude of 100 feet
100-199	37.0	100.0
200-299	13.0	63.0
300-399	4.3	50.0
400-499	10.9	45.7
500-599	8.7	34.8
600-699	8.7	26.1
700 and up	17.4	17.4

HELICOPTER ATTITUDE IN ESCAPE SITUATION FATAL ACCIDENTS

The following table shows the approximate attitude of the helicopter at the estimated moment when the pilot would have actuated the in-flight escape system.

TABLE XII
HELICOPTER ATTITUDE IN ESCAPE SITUATION FATAL ACCIDENTS

Helicopter Attitude	Number of Escape Situation Fatal Accidents
Level	23
Bank	1
Climb	3
Descent	1
Descending turn	3
Out of control (stall/spin)	14
Unknown	1

SURVIVABLE NON-ESCAPE SITUATION ACCIDENTS

The potential value of various survival mechanisms in non-escape situation accidents is shown in Table XIII in terms of preventing fatalities.

TABLE XIII

SURVIVAL MECHANISM POTENTIAL IN NON-ESCAPE SITUATION ACCIDENTS

Survival Mechanism	Number of Accidents	Number of Fatalities	Non-Escape Situation Fatalities Percent	All Fatalities Percent*
Fire and impact protection	8	22	21.1	6.0
Emergency flotation only	3	6	5.8	1.6
Flotation and impact protection	1	2	1.9	0.6
Fire protection only	9	17	16.4	4.6
Impact protection only	29	57	54.8	15.5
Total	50	104	100.0	28.3

*367 fatalities

NONSURVIVABLE SITUATION ACCIDENTS

There were 26 fatal accidents involving 62 fatalities in situations considered to be nonsurvivable. These accidents were due mainly to collisions with terrain, with wires, or with other aircraft, and either were too low or the pilots were judged to be unable to effect in-flight escape. One victim was struck by a rotor blade, and, although the other occupant bailed out incurring injuries which were less than critical, the occurrence was judged to be nonsurvivable since no reasonable impact protection could have prevented the fatality. One critical injury accident was deemed unavoidable because of high impact forces.

UNKNOWN SURVIVABILITY SITUATION ACCIDENTS

There were 22 fatal accidents with 45 fatalities in which survival judgments could not be made because of insufficient information in the available accident reports.

It can be hypothesized that a percentage of these accidents would have met the in-flight escape system criteria or would otherwise have been candidates for survival.

CAUSES OF FATALITIES

Analysis of the accident reports indicates that most of the fatalities are from drowning, servere burns, or multiple extreme injuries. The fatalities are categorized in Table XIV.

TABLE XIV
CAUSES OF FATALITIES

Cause of Fatality	Number of Fatalities in Escape Situation Accidents	Number of Fatalities in All Accidents
Drowned/lost and presumed drowned	0	8
Carbonization and burns	117	243
Multiple extreme injuries	28	60
Other/unknown	12	56

FIRE INVOLVEMENT IN ALL HELICOPTER OCCUPANT FATALITIES

The following table summarizes all postcrash fire involvement in the various categories of helicopter occupant fatalities.

TABLE XV

INCIDENCE OF FIRE IN ALL FATAL HELICOPTER ACCIDENTS

Accident Category	Number of Fatal Accidents	Number of Fatalities	Percentage of Category	Percentage of All Fatalities
Fire involvement in all occupant fatalities (367)	81	237	64.6	64.6
Fire involvement in escape situation fatalities (157)	30	113	71.9	30.9
Fire involvement in nonsurvivable situation fatalities (62)	8	21	33.9	5.7
Fire involvement in survivable non-escape situation fatalities (104)	34	81	77.8	22.0
Fire involvement fatalities in accidents with unknown survivability (44)	9	22	50.0	6.0

COMPOSITE HELICOPTER ACCIDENT DATA, U.S. ARMY 1958-1965, U.S. NAVY 1952-1965

Figures 11 through 30 show graphically the fatal accident, fatality, and survival requirement trends for the combined study of Army and Navy helicopter accident data for the 14-year period from 1952 through 1965.

The annual distribution of Navy helicopter fatal accidents (Figure 11) shows a gradual decrease, while the Army data (Figure 16) show a decided increase, particularly for the last two years (1964 and 1965).

Figure 26 is a composite of the distribution of the Army and Navy fatal accident data. This figure shows an overall increase in the number of accidents, but the trend is less drastic.

Figure 31 shows the significant increase in the number of hours flown each year during the timespan of this study. The results of this constantly growing use of helicopters are reflected in Figures 12, 17 and 27, which show the rates for fatal accidents (number of accidents per 10,000 flying hours) to be gradually decreasing.

Figure 32 illustrates the fact that the average number of occupants per helicopter in a fatal accident has doubled during the 14-year period of this study. It is felt that this trend will continue and that future flying activities will involve ever larger numbers of personnel.

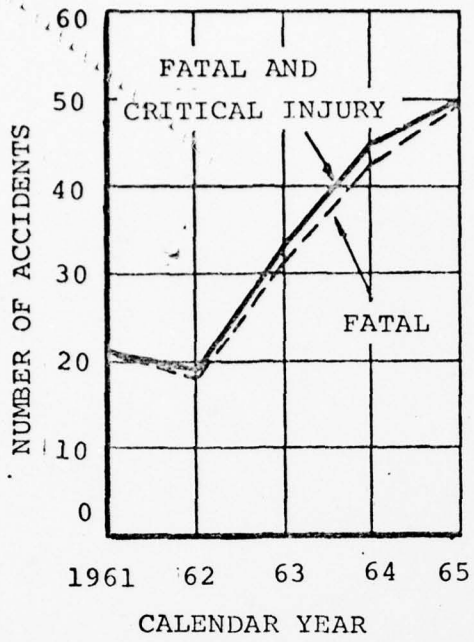


Figure 21. Total Fatal and Critical Injury Accidents, U.S. Army and U.S. Navy, 1961-1965

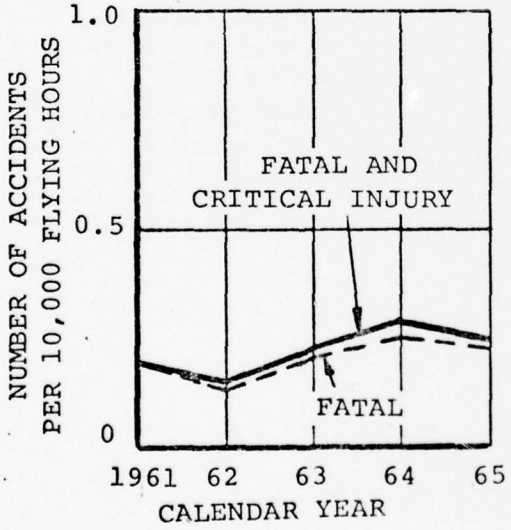


Figure 22. Fatal and Critical Injury Accident Rate, U.S. Army and U.S. Navy, 1961-1965

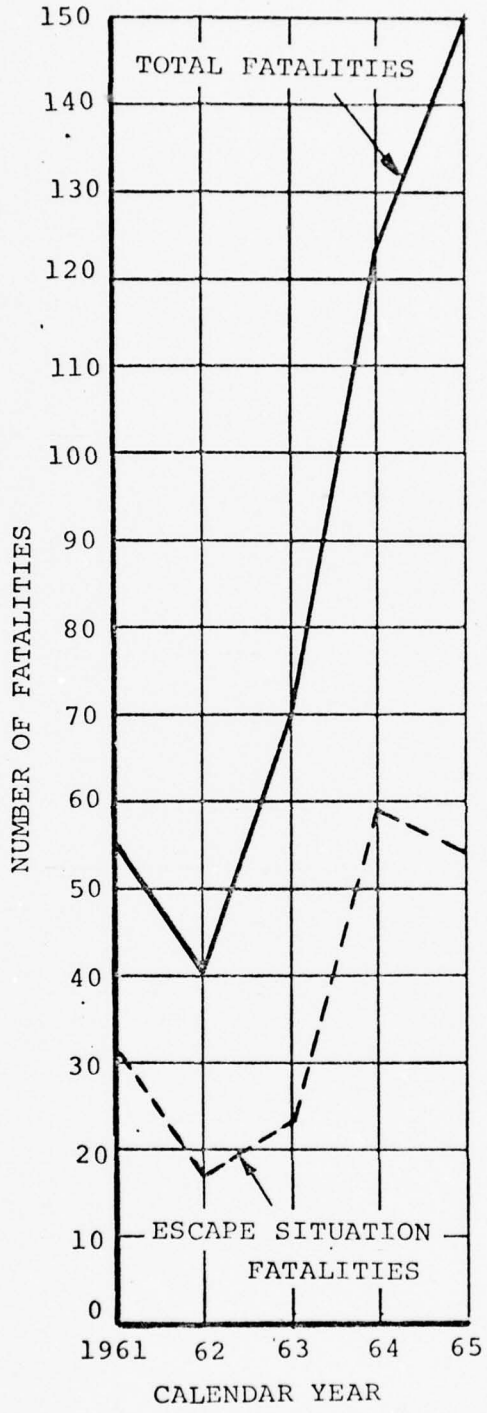


Figure 23. Annual Distribution of Fatalities, U.S. Army and U.S. Navy, 1961-1965

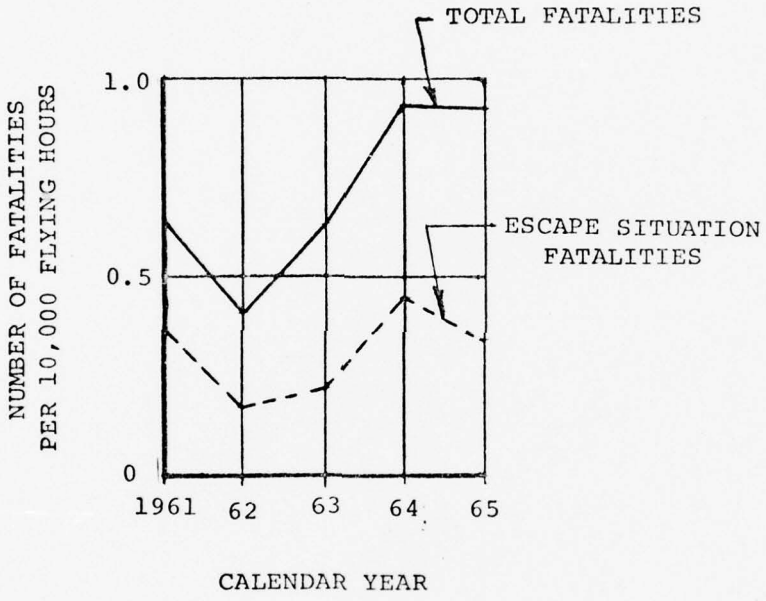
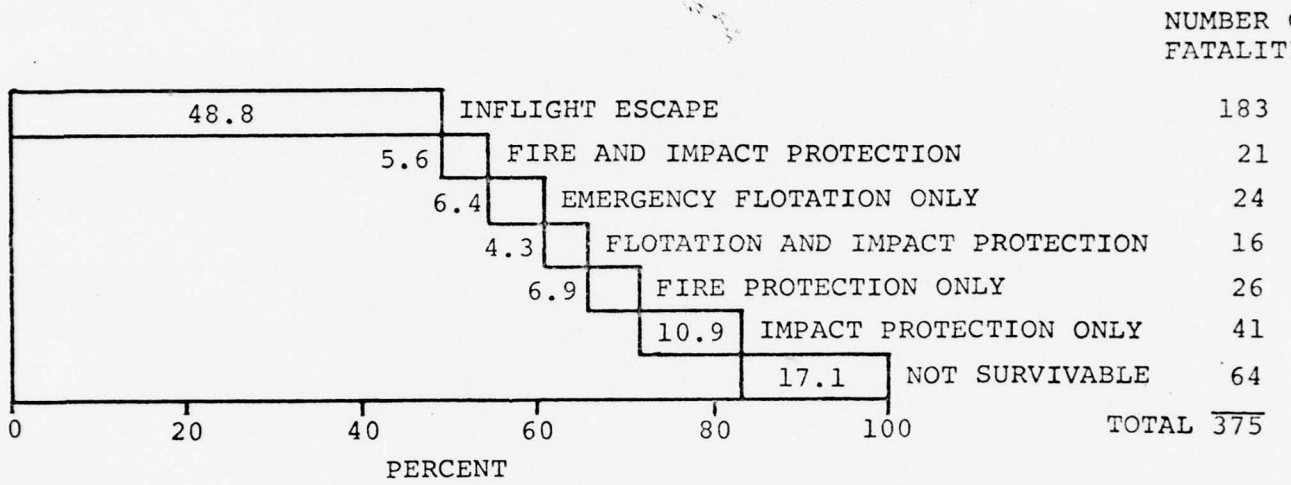


Figure 24. Rate of Fatalities, U.S. Army and U.S. Navy, 1961-1965



NOTE: THERE WERE 26 ADDITIONAL ACCIDENTS INVOLVING 61 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 25. Survival Mechanism Potential as Applied to 136 Accidents with 375 Fatalities, U.S. Army/U.S. Navy, 1961-1965

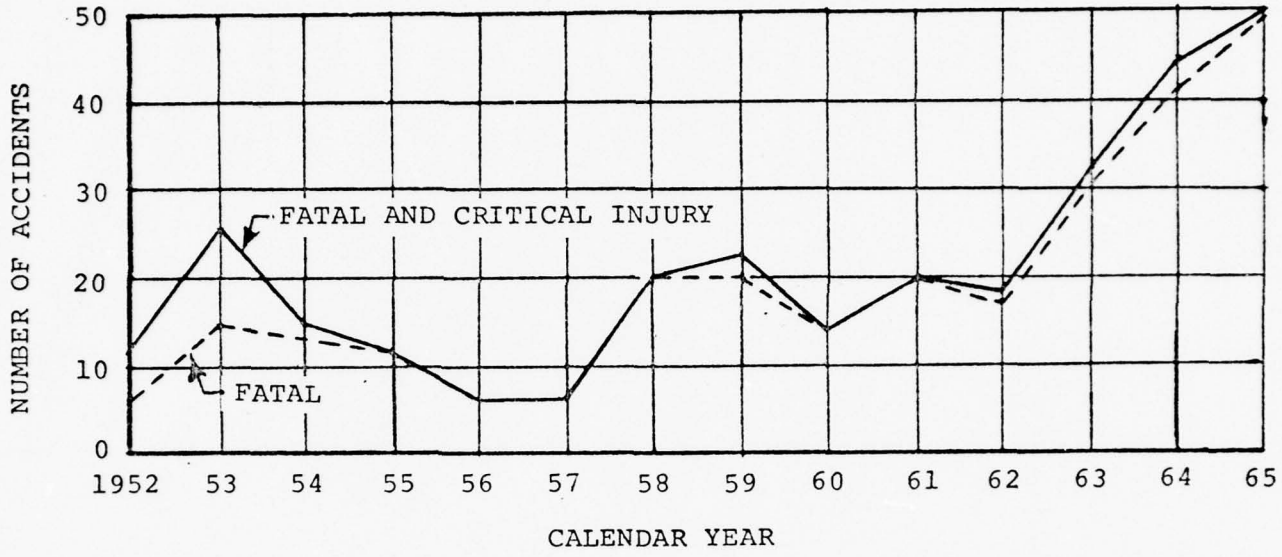


Figure 26. Total Fatal and Critical Injury Accidents, U.S. Army 1958-1965, U.S. Navy 1952-1965

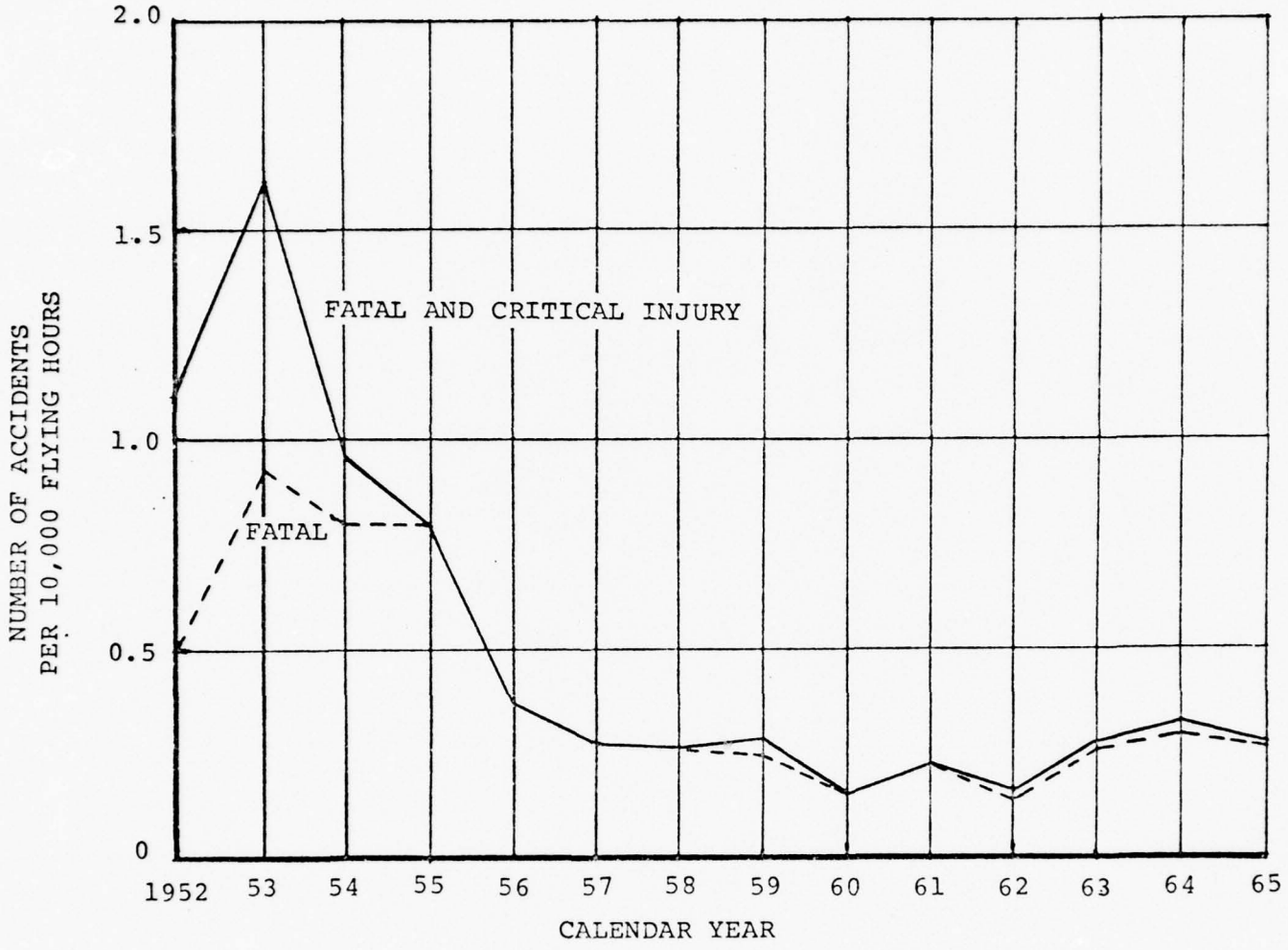


Figure 27. Fatal and Critical Injury Accident Rate, U.S. Army 1958-1965, U.S. Navy 1952-1965

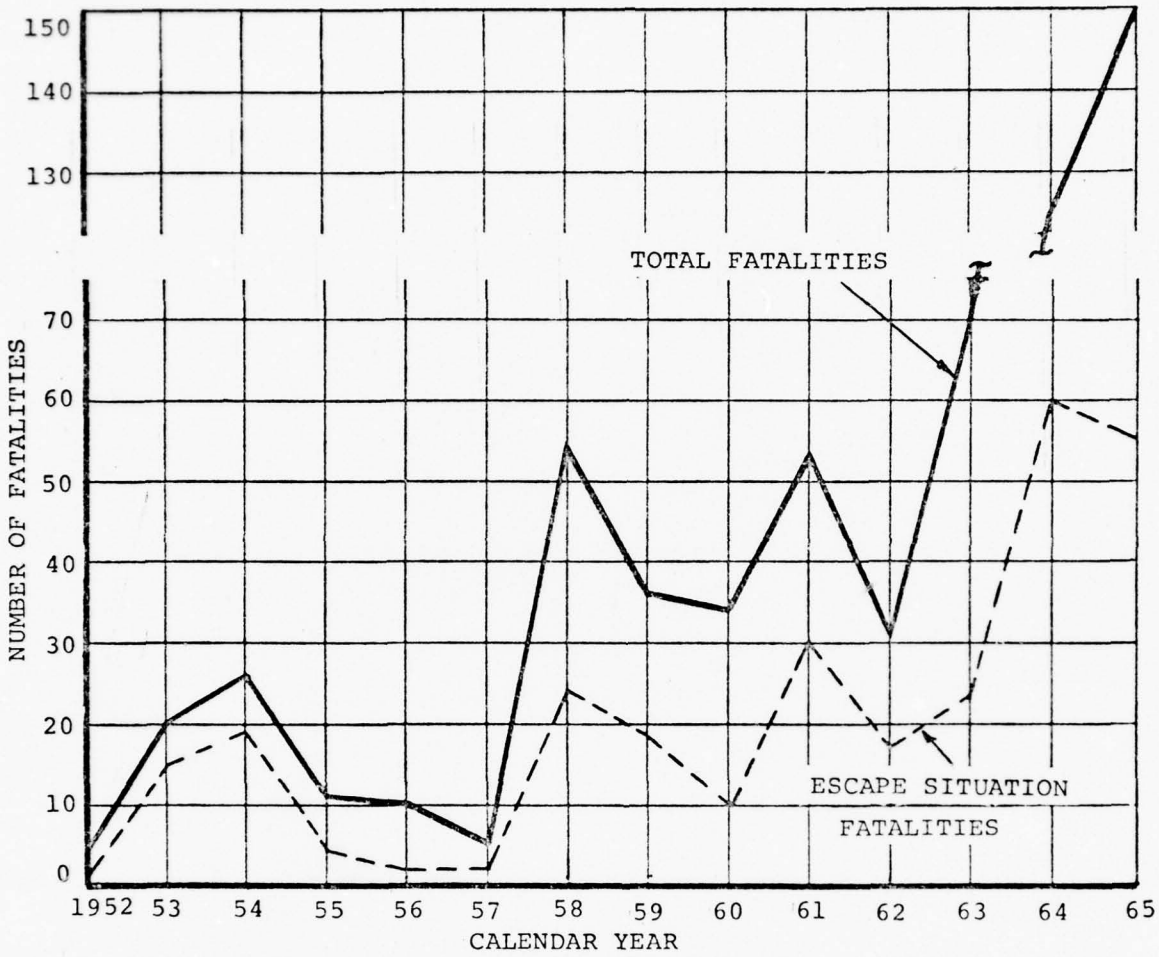


Figure 28. Annual Distribution of Fatalities, U.S. Army 1958-1965, U.S. Navy 1952-1965

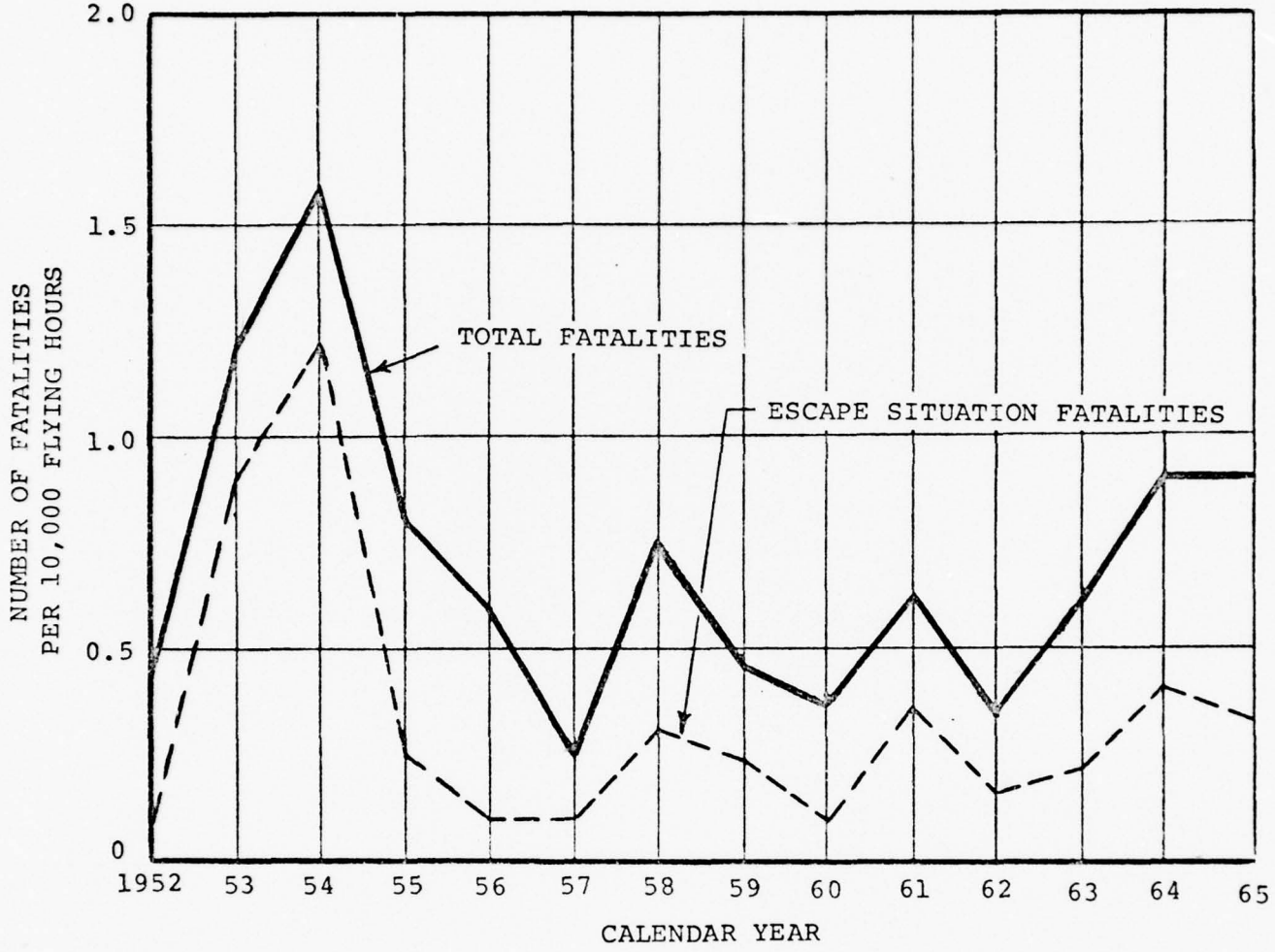
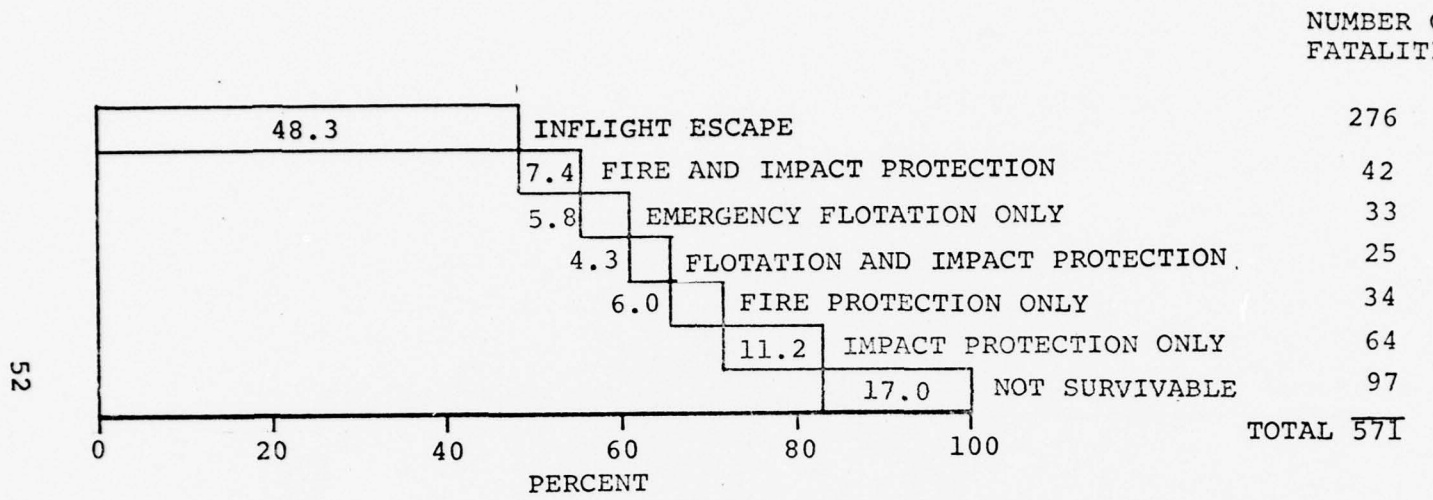


Figure 29. Rate of Fatalities, U.S. Army 1958-1965, U.S. Navy 1952-1965



NOTE: THERE WERE 30 ADDITIONAL ACCIDENTS INVOLVING 71 FATALITIES. THE SURVIVAL POTENTIAL OF THESE ACCIDENTS IS CONSIDERED UNKNOWN.

Figure 30. Survival Mechanism Potential as Applied to 231 Accidents with 571 Fatalities, U.S. Army 1958-1965, U.S. Navy, 1952-1965

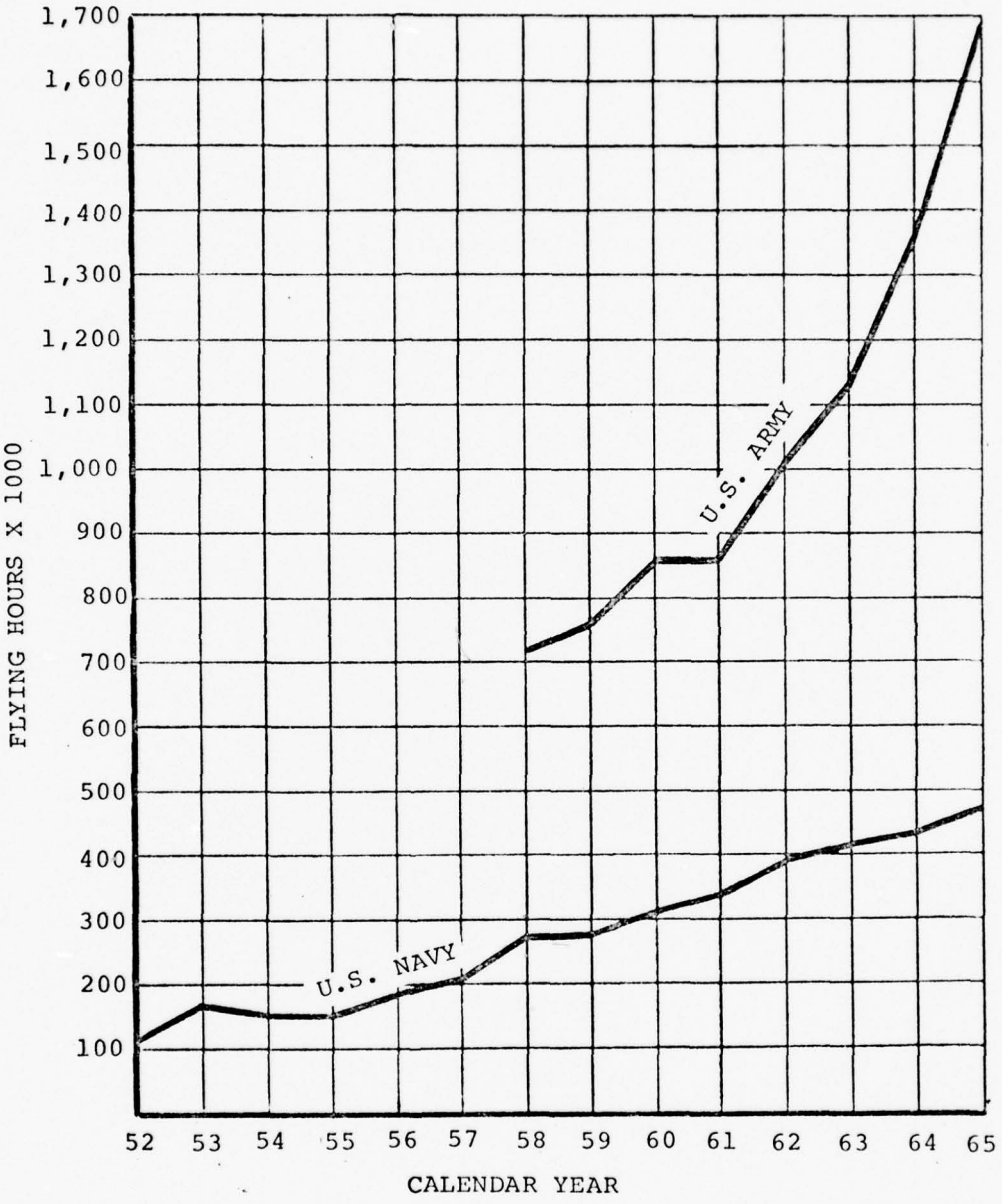


Figure 31. Annual Total of Helicopter Flying Hours, U.S. Army 1958-1965, U.S. Navy 1952-1965

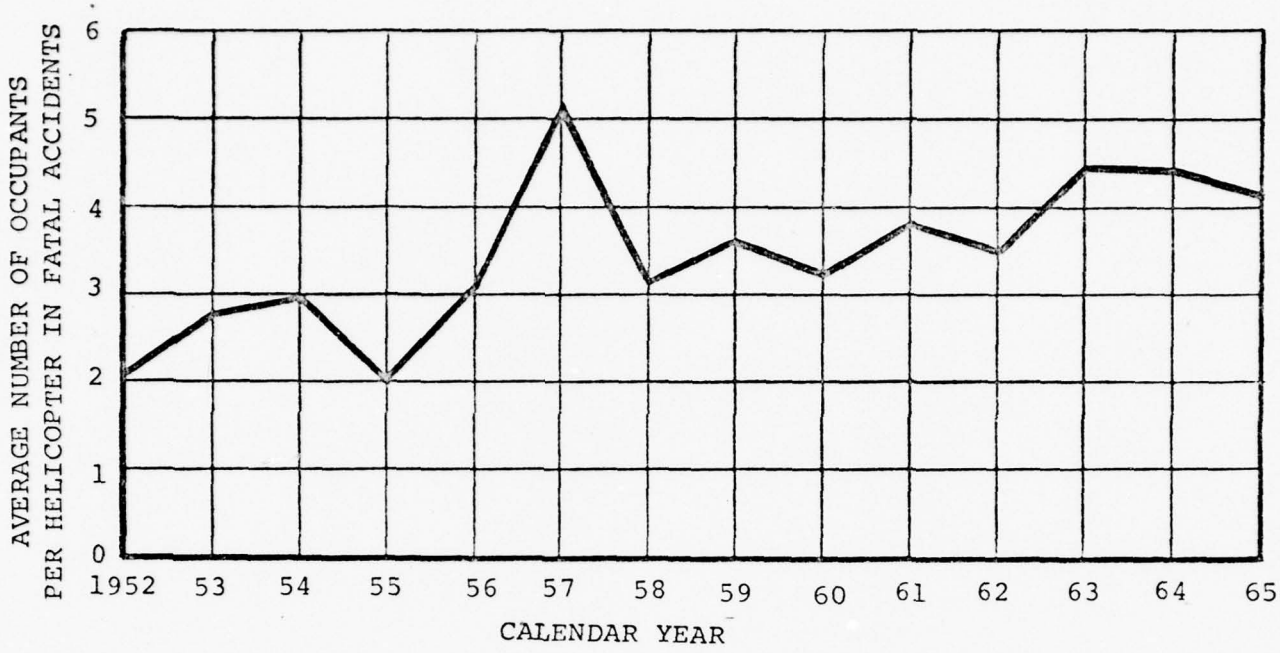


Figure 32. Average Number of Occupants per Helicopter in Fatal Accidents, U.S. Army 1958-1965, U.S. Navy 1952-1965

RECAPITULATION

The following information is presented to highlight changes in trends and shifts in emphasis between this study and the previous study. While the data presented here are brief and do not attempt to summarize all that has been learned in this accident data study, they are sufficient to show the degree and nature of some of the changes that have occurred. These facts are representative of the type of information that can be gained from a thorough study of the tables in the appendixes.

The following figures show changes and correlations in various categories for all fatal and critical injury accidents between the early study, which covered U.S. Navy helicopter accidents from 1952 through 1960, and this study, with its expanded coverage over a longer timespan. All figures given are percentages.

	Early Study	Current Study
1. Type of Duty		
Training	47.6	26.1
Administrative	19.1	22.1
Operational	14.2	42.7
Other	19.1	9.1
2. Phase of Operation		
In flight	55.2	75.8
Takeoff and landing	41.1	22.1
Ground and other	3.7	2.1
3. Fire Involvement	41.1	85.4

	Early Study	Current Study
4. Cause Factors		
Operational	44.8	50.9
Material	27.2	20.8
Maintenance	14.0	7.5
Other	14.0	20.8
5. System Malfunction		
Powerplant	35.7	35.8
Drive and rotor	14.3	19.4
Other	50.0	44.8

CONCLUSIONS

An estimated 43.3 percent of all helicopter occupant fatalities could have been prevented had an in-flight escape system been available (See Figure 30).

An additional 30.1 percent of fatalities were judged to have been potential candidates for survival with the incorporation of such improved crash safety and survival provisions as impact protection, crash fire prevention, and emergency flotation (See Figure 30).

When all criteria for a successful in-flight escape are met except that the aircraft is controllable, it is presumed that the pilot would normally choose to make an autorotational landing. However, certain factors must be taken into account which might dictate the use of the in-flight escape system in preference to autorotation. One such situation would involve an emergency over terrain that is steeply sloping or hilly. In such a case the aircraft would probably roll after landing with the distinct possibility of overturning and burning; this likelihood would make the use of the in-flight escape system the wiser course of action. A similar situation would involve an emergency over terrain that is densely covered with tall trees. Here the use of the in-flight escape system would permit a clean descent through the trees, in contrast with the rotor blades contacting the trees before the completion of an autorotational landing. Other circumstances which make autorotational landings undesirable are darkness and unfavorable weather. It will be necessary for the using activities to evaluate emergency procedures with the goal of establishing ground rules for the proper use of the in-flight escape system.

Helicopters and flight crews have proved themselves capable of meeting the demands placed upon them. It is anticipated that they will continue to lead the state of the art with respect to design and operating technique.

However, considering the anticipated increased numbers of helicopters, flight crews, passengers, and flying hours and the inevitable accidents precipitated by such future activities, the need for an in-flight escape system and other crash protection features is obvious.

RECOMMENDATIONS

Because larger helicopters carrying more crewmen and passengers are in use, the average number of fatalities per accident has increased. Since this study has shown that 43.3 percent of all occupant fatalities could have been prevented by an in-flight escape system, it is recommended that a choice of helicopter types be made in which a capsule escape system could be installed.

The study also shows that an additional 30.1 percent of occupant fatalities were candidates for survival through the application of improved crash safety and survival provisions. It is therefore recommended that present state-of-the-art energy-absorbing devices (landing gear, structure, seats), fire prevention and suppression methods, and flotation capabilities be incorporated into a personnel survival system to be used in conjunction with the capsule escape system.

APPENDIX I

TABULAR HELICOPTER ACCIDENT DATA, U.S. NAVY, 1952-1965

TABLE XVI
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1952-1965

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents		Critical Injury Accidents	
		Number	Rate*	Number	Rate*	Number	Rate*
H-1 (UH-1E)	36,076	6	1.6	0	-	-	-
H-2 (HU2K)	87,079	48	5.5	1	0.1	-	-
H-3 (HSS-2)	275,989+	33	1.1	12	0.4	-	-
H-13L/M/N (HTL)	340,046	124	3.6	5	0.1	1	0.03
H-13P/Q/R (HUL)	20,272	8	3.9	1	0.5	-	-
H-19E (HRS)	497,886	235	4.7	18	0.4	6	0.1
H-19F/G (HO4S)	121,552	67	5.5	6	0.4	-	-
H-25 (HUP)	498,697	245	4.9	19	0.4	4	0.1
H-34D/E/F (HUS)	947,845	148	1.5	19	0.2	2	0.02
H-34G/H/J (HSS-1)	667,055	114	1.7	17	0.3	-	-
H-37 (HR2S)	71,738	26	3.6	6	0.8	-	-
H-43C (HUK)	29,711	12	4.0	1	0.3	-	-
H-43D (HOK)	101,300	55	5.4	9	0.8	-	-
H-46 (CH-46A)	23,025	1	0.4	0	-	-	-
HO3-S	43,012	45	10.5	7	1.6	2	0.5
HO5-S	40,110	50	12.5	3	0.7	3	0.7
HRP	7,020	8	11.4	0	-	-	-
HSL	2,063	3	14.5	1	4.8	-	-
HTE	11,769	12	10.2	3	2.6	1	0.8
HTK	11,148	10	8.9	4	3.6	2	1.7
HSO	276	0	-	0	-	-	-
Total or Average	3,833,669	1,250	3.36	137	0.36	21	0.06

* Number of accidents per 10,000 flying hours

TABLE XXXI
IDENTIFICATION OF SYSTEMS INVOLVED IN HELICOPTER

TABLE XVII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1961-1965

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	36,076	6	1.6	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	87,079	48	5.5	6	0.7	13	1.5	-	-	-	-	-
H-3(HSS-2)	275,989	30	1.1	11	0.4	24	0.9	-	-	-	-	-
H-13L/M/N (HTL)	107,641	17	1.5	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	7,293	2	2.7	1	1.3	2	2.7	-	-	-	-	-
H-19E (HRS)	83,674	22	2.6	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	27,853	2	0.7	-	-	-	-	-	-	-	-	-
H-25 (HUP)	103,763	28	2.6	3	0.3	3	0.3	-	-	-	-	-
H-34D/E/F (HUS)	759,555	101	1.5	16	0.2	61	0.8	2	1	0.01	3	0.04
H-34G/H/J (HSS-1)	396,218	52	1.2	8	0.2	19	0.5	1	-	-	-	-
H-37(HR2S)	41,754	7	1.7	2	0.5	7	1.7	-	-	-	-	-
H-43C (HUK)	18,357	6	3.2	1	0.5	2	1.1	-	-	-	-	-
H-43D (HOK)	43,449	15	3.4	2	0.5	6	1.4	-	-	-	-	-
H-46 (CH-46A)	23,025	1	0.4	-	-	-	-	-	-	-	-	-
H-50 (DSN)	276	-	-	-	-	-	-	-	-	-	-	-
Total or Average	2,012,002	337	1.7	50	0.2	137	0.7	3	1	0.005	3	0.015

* Number per 10,000 flying hours

TABLE XVIII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1961

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	-	-	-	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	2	-	-	-	-	-	-	-	-	-	-	-
H-3(HSS-2)	10,966	1	0.9	-	-	-	-	-	-	-	-	-
H-13L/M/N (HTL)	18,047	1	0.6	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	2,708	1	3.7	-	-	-	-	-	-	-	-	-
H-19E (HRS)	22,210	5	2.2	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	11,804	1	0.8	-	-	-	-	-	-	-	-	-
H-25 (HUP)	47,088	13	2.8	2	0.4	2	0.4	-	-	-	-	-
H-34D/E/F (HUS)	110,371	5	0.4	1	0.1	2	0.2	-	-	-	-	-
H-34G/H/J (HSS-1)	87,162	19	2.2	3	0.3	6	0.7	-	-	-	-	-
H-37(HR2S)	10,695	1	0.9	1	0.9	3	2.8	-	-	-	-	-
H-43C (HUK)	2,273	2	8.8	-	-	-	-	-	-	-	-	-
H-43D (HOK)	13,614	5	3.7	-	-	-	-	-	-	-	-	-
H-46 (CH-46A)	-	-	-	-	-	-	-	-	-	-	-	-
H-50 (DSN)	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	336,940	54	1.6	7	0.2	13	0.4	-	-	-	-	-

* Number per 10,000 flying hours

TABLE XIX
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1962

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	-	-	-	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	1,222	1	8.2	-	-	-	-	-	-	-	-	-
H-3(HSS-2)	32,660	7	2.1	4	1.2	7	2.1	-	-	-	-	-
H-13L/M/N (HTL)	23,204	3	1.3	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	2,529	-	-	-	-	-	-	-	-	-	-	-
H-19E (HRS)	22,531	5	2.2	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	10,901	1	0.9	-	-	-	-	-	-	-	-	-
H-25 (HUP)	37,617	9	2.4	1	0.3	1	0.3	-	-	-	-	-
H-34D/E/F (HUS)	139,871	13	0.9	1	0.1	7	0.5	-	-	-	-	-
H-34G/H/J (HSS-1)	80,520	7	0.9	1	0.1	1	0.1	-	-	-	-	-
H-37(HR2S)	8,672	2	2.3	-	-	-	-	-	-	-	-	-
H-43C (HUK)	2,628	1	3.8	-	-	-	-	-	-	-	-	-
H-43D (HOK)	15,073	5	3.3	-	-	-	-	-	-	-	-	-
H-46 (CH-46A)	-	-	-	-	-	-	-	-	-	-	-	-
H-50 (DSN)	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	377,704	54	1.4	7	0.2	16	0.4	-	-	-	-	-

* Number per 10,000 flight hours

TABLE XX
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1963

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	141	-	-	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	14,889	12	8.0	2	1.3	3	2.0	-	-	-	-	-
H-3(HSS-2)	65,929	9	1.4	4	0.6	9	1.4	-	-	-	-	-
H-13L/M/N (HTL)	22,940	3	1.3	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	2,056	1	4.9	1	4.9	2	9.7	-	-	-	-	-
H-19E (HRS)	18,165	9	5.0	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	5,148	-	-	-	-	-	-	-	-	-	-	-
H-25 (HUP)	16,692	5	3.0	-	-	-	-	-	-	-	-	-
H-34D/E/F (HUS)	167,031	17	1.0	4	0.2	10	0.6	-	-	-	-	-
H-34G/H/J (HSS-1)	68,142	7	1.0	1	0.1	2	0.3	-	-	-	-	-
H-37(HR2S)	8,258	1	1.2	-	-	-	-	-	-	-	-	-
H-43C (HUK)	1,961	1	5.1	-	-	-	-	-	-	-	-	-
H-43D (HOK)	14,762	5	3.4	2	1.4	6	4.1	-	-	-	-	-
H-46 (CH-46A)	125	-	-	-	-	-	-	-	-	-	-	-
H-50 (DSN)	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	406,239	70	1.7	14	0.3	32	0.8	-	-	-	-	-

* Number per 10,000 flying hours

TABLE XXI
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1964

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	8,970	2	2.2	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	33,766	22	6.5	3	0.8	8	2.4	-	-	-	-	-
H-3(HSS-2)	80,486	6	0.7	1	0.1	3	0.4	-	-	-	-	-
H-13L/M/N (HTL)	22,338	6	2.7	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	-	-	-	-	-	-	-	-	-	-	-	-
H-19E (HRS)	15,011	1	0.7	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	-	-	-	-	-	-	-	-	-	-	-	-
H-25 (HUP)	2,364	1	4.2	-	-	-	-	-	-	-	-	-
H-34D/E/F (HUS)	180,338	35	1.9	6	0.3	29	1.6	-	1	0.1	3	0.2
H-34G/H/J (HSS-1)	70,955	5	0.7	-	-	-	-	-	-	-	-	-
H-37(HR2S)	8,074	3	3.7	1	1.2	4	5.0	-	-	-	-	-
H-43C (HUK)	9,772	2	2.0	1	1.0	2	2.0	-	-	-	-	-
H-43D (HOK)	-	-	-	-	-	-	-	-	-	-	-	-
H-46 (CH-46A)	3,345	1	3.0	-	-	-	-	-	-	-	-	-
H-50 (DSN)	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	435,419	84	1.9	12	0.3	46	1.1	-	1	0.02	3	0.07

* Number per 10,000 flying hours

TABLE XXII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. NAVY, 1965

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
H-1(UH-1E)	26,965	4	1.5	-	-	-	-	-	-	-	-	-
H-2 (HU2K)	37,200	13	3.5	1	0.3	2	0.5	-	-	-	-	-
H-3(HS6-2)	85,948	7	0.8	2	0.2	5	0.6	-	-	-	-	-
H-13L/M/N (HTL)	21,112	4	1.9	-	-	-	-	-	-	-	-	-
H-13P/Q/R (HUL)	-	-	-	-	-	-	-	-	-	-	-	-
H-19E (HRS)	5,757	2	3.5	-	-	-	-	-	-	-	-	-
H-19F/G (HO4S)	-	-	-	-	-	-	-	-	-	-	-	-
H-25 (HUP)	2	-	-	-	-	-	-	-	-	-	-	-
H-34D/E/F (HUS)	161,944	31	1.8	4	0.2	13	0.8	2	-	-	-	-
H-34G/H/J (HSS-1)	89,439	14	1.6	3	0.3	10	1.1	1	-	-	-	-
H-37(HR2S)	6,055	-	-	-	-	-	-	-	-	-	-	-
H-43C (HUK)	1,723	-	-	-	-	-	-	-	-	-	-	-
H-43D (HOK)	-	-	-	-	-	-	-	-	-	-	-	-
H-46 (CH-46A)	19,555	-	-	-	-	-	-	-	-	-	-	-
H-50 (DSN)	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	455,700	75	1.6	10	0.2	30	0.6	3	-	-	-	-

* Number per 10,000 flying hours

TABLE XXIII
TYPE OF DUTY OF HELICOPTERS IN FATAL AND
CRITICAL INJURY ACCIDENTS, U. S. NAVY, 1961-1965

Duty Class	Training				Operations				
					Navy			Marines	
	Res(N)	Res(M)	Basic	Adv	NAS and Misc	Fleet Util	Helo Sqd	MCAS and Misc	Marine Helo Sqd
Number	1	-	1	-	3	1	25	6	14
	2				29			20	
Percent	2.0	-	2.0	-	5.9	2.0	49.0	11.7	27.4
	3.9				56.9			39.2	

TABLE XXIV
TYPE OF OPERATION OF HELICOPTERS IN FATAL AND CRITICAL INJURY ACCIDENTS, U. S. NAVY, 1961-1965

Type of Operation	CV/LPH	Field	GCA/ILS	Ship Operations Other Than CV
Number	15	31	2	3
	Total 51			
Percent	29.4	60.8	3.9	5.9

TABLE XXV
FATAL ACCIDENT RATES INVOLVING CARRIER-TYPE HELICOPTERS, U. S. NAVY, 1962-1965

Type of Operation	Fatal Accidents							
	1962		1963		1964		1965	
	No.	Rate*	No.	Rate	No.	Rate	No.	Rate
Disembarked	3	0.2	9	0.4	9	0.2	6	0.2
Embarked	4	0.5	5	0.5	5	0.6	4	0.5

*Number per 10,000 flying hours

TABLE XXVI
TYPE OF FLIGHT IN HELICOPTER ACCIDENTS,
U. S. NAVY, 1961-1965

Type of Flight	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Unit Training	18	115	35.3	34.1
Individual Proficiency	1	6	2.0	1.8
Student Aviator Training	-	17	-	5.0
Ferry	2	13	3.9	3.9
Experimental Evaluation Development	-	3	-	0.9
Flight Check	1	17	2.0	5.0
Utility Aviation Forces	5	21	9.8	6.2
Utility Nonaviation Forces	4	32	7.8	9.5
Search and Rescue	-	8	-	2.4
Miscellaneous Nontraining	5	18	9.8	5.3
Scheduled Logistic Transport	-	5	-	1.5
Nonscheduled Logistic Transport	2	14	3.9	4.2
Hospital Patient Transport	-	2	-	0.6
Administrative Transport	10	23	19.6	6.8
Troop Support Transport	-	8	-	2.4
Reconnaissance Photographic	2	1	3.9	0.3
Embarked or Otherwise Outside Conus*	1	34	2.0	10.1
Total	51	337		

*Includes 16 classified accidents

TABLE XXVII

PHASE OF OPERATION IN HELICOPTER ACCIDENTS,
U. S. NAVY, 1961-1965

Phase of Operation	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Static	-	13	-	4
Taxi	-	2	-	1
Takeoff	6	47	11.8	14
In Flight	36	167	70.6	49
Landing	8	62	15.7	18
Waveoff	1	7	1.9	2
Autorotation	-	39	-	12
Total	51	337		

TABLE XXVIII
DAMAGE CLASSIFICATION OF HELICOPTER ACCIDENTS,
U. S. NAVY, 1961-1965

Damage Class		Strike	Overhaul	Substantial
Number	All	193	86	58
		Total 337		
	Fatal and Critical Injury	49	2	-
		Total 51		
Percent	All	57	26	17
	Fatal and Critical Injury	96	4	-

TABLE XXIX
INCIDENCE OF FIRE AND TYPE OF SURFACE CONTACT IN HELICOPTER ACCIDENTS, U. S. NAVY, 1961-1965

		Total Helicopter Accidents				Fatal and Critical Injury Accidents			
Number		337				51			
Fire Involved	Number	56				20			
	Percent	16.5				39.2			
Type Surface Contact of Accidents Involving Fire*		Ground		Water		Ground		Water	
	Number	49		5		18		2	
	Percent	87.5		9.0		90.0		10.0	
		In Flight	Im-pact	In Flight	Im-pact	In Flight	Im-pact	In Flight	Im-pact
Inception of Fire**	Number	3	42	4	1	1	17	1	1
	Percent	6.0	86.0	80.0	20.0	5.5	94.4	50.0	50.0

* Two accidents involving fire did not specify ground or water impact.
** Four accidents involving fire occurred during ground operation.

TABLE XXX
CAUSE FACTORS IN HELICOPTER ACCIDENTS,
U. S. NAVY, 1961-1965

Cause Factor	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Pilot	20	168	26.7	36.4
Other Personnel	10	71	13.3	15.4
Mat'l. Failure or Malfunction	15	138	20.0	29.9
Mat'l.-Design *or Mfg Person* Induced	5	24	6.7	5.2
Weather	9	26	12.0	5.6
Airport Facility	1	2	1.3	0.4
Carrier Facility	1	2	1.3	0.4
Other	-	4	-	0.9
Unknown	13	26	17.4	5.6
Unavoidable	1	1	1.3	0.2
Total	75	462	-	-

TABLE XXXI
IDENTIFICATION OF SYSTEMS INVOLVED IN HELICOPTER ACCIDENTS, U. S. NAVY, 1961-1965

Helicopter System	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Airframe	-	7	-	5.1
Brakes	-	-	-	-
Flight Controls	2	11	13.3	8.0
Escape/Survival	-	-	-	-
Electrical/Electronic	1	4	6.7	2.9
Fuel	-	1	-	0.7
Gunnery/Ordnance	-	-	-	-
Hydraulic/Pneumatic	-	-	-	-
Instruments	1	4	6.7	2.9
Auxiliary Equipment	1	1	6.7	0.7
Alighting Gear	1	2	6.7	1.4
Engine Controls	-	1	-	0.7
Reciprocating Engine	5	47	33.3	34.1
Turboshaft Engine	-	21	-	15.2
Unknown	2	20	13.3	14.5
Power Train/Rotor	2	19	13.3	13.8
Total	15	138		

TABLE XXXII
INCIDENCE OF SYSTEM MALFUNCTIONS IN HELICOPTER ACCIDENTS,
U. S. NAVY, 1961-1965

	Number	Percent
Total Helicopter Accidents	337	100
Total Accidents Involving System Malfunctions	124	36.6
Fatal and Critical Injury Accidents	51	15.1
Fatal and Critical Injury Accidents Involving System Malfunctions	13	25.5

TABLE XXXIII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. NAVY HELICOPTER FATAL ACCIDENTS, 1961

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
HSS-1N				X						50		X			X				X			2	1			X			lost rotor rpm
HUS-1						X				50		X		X				X			X	5	2				X		lost airspeed
HUP-3				X						40	X				X			X				2	1			X			hit carrier fantail, then hit water
HSS-1N								X		800	X			X					X			4	4		X				throttle stuck open, autorotation, nose pitchup
HR2S-1					X					600		X	X	X					X		X	3	3		X				disintegrated in flight, flight control failure
HUP-3							X			70	X		X		X			X				2	1			X			engine failure
HSS-1N			X							100-	X				X			X			X	3	1			X			disorientation during night launch

TABLE XXXIV
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. NAVY HELICOPTER FATAL ACCIDENTS, 1962

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
HUP-3									X	75	X				X				X			2	1			X			hit carrier deck edge and impacted water
HSS-2					X					0	X				X			X				4	1			X	X		flew into water at night
HUS-1					X					0		X		X				X			X	8	7					X	flew into mountain, poor weather, vertigo
HSS-2				X						0	X				X			X				4	2			X			flew into water at night, suspect disorientation
HSS-2				X						0	X				X				X			3	2			X	X		flew into water at night, suspect disorientation
HSS-2				X						80	X			X	X				X			3	2			X	X		suspect flight control malfunction, wreckage not recovered
HSS-1						X				0	X					X			X		X	3	1					X	poor landing approach technique

TABLE XXXV

DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. NAVY HELICOPTER FATAL ACCIDENTS, 1963

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
SH-3A					X					0		X	X		X			X				4	2			X	X		flew into water at night, suspect radar altimeter malfunction
UH-2A						X				0		X			X			X				4	1				X		flew into water at night
UH-34D						X				100-		X		X				X			X	8	6				X	X	aircraft settled in downdraft turbulence
UH-34D				X						100		X		X				X			X	4	1				X	X	hoist sling caught in tree
SH-34G					X					600	X		X		X				X			4	2		X				suspect flight control malfunction, wreckage not recovered
UH-34D					X					500		X		X				X			X	9	1					X	poor weather, lost rotor rpm
UH-2A				X						50		X			X				X			4	2			X	X		flight control loss, maintenance error
UH-34E				X						18		X	X		X				X			4	2			X	X		engine failure
OH-43D					X					4200		X		X					X			3	3		X				aircraft entered IFR conditions, pilot disorientation
SH-3A					X					unk	X		X		X				X			4	4		unknown				reported directional control lost, wreckage not recovered
SH-3A				X						0	X		X		X				X			4	1			X	X		flew into water at night with known altimeter malfunction
OH-43D					X					130		X		X			X		X		X	3	3						flew into wires, nonsurvivable
UH-13P					X					unk	X		X		X				X			2	2		unknown				tail rotor failure, no survivors, no witnesses
SH-3A						X				100-	X				X			X				5	2			X	X		flew into water at night during carrier-controlled approach

TABLE XXXVI
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. NAVY HELICOPTER FATAL ACCIDENTS, 1964

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
SH-3A					X					3500		X	X		X				X	X		3	3		X				rotor brake hydraulic system malfunction
UH-34D					X					0		X		X				X			X	12	12						flew into mountain VFR, non-survivable
UH-43C			X							250		X			X				X			2	2						in-flight explosion, cause unknown, nonsurvivable
UH-2A		X								0	X				X				X			2	1						control loss, maintenance error, fatality struck by blade, non-survivable
UH-34D				X						50	X				X				X			3	1			X			lost rotor rpm
UH-34D				X						50		X		X					X		X	4	1					X	partial power failure at takeoff
UH-2A					X					1200		X	X	X					X		X	6	6		X				rotor blade failure
CH-37C			X							200+		X	X	X					X		X	4	4		X				lost tail rotor in flight
UH-34D					X					400		X		X			X		X		X	11	9		X				midair collision
UH-34D					X			X		110	X		X		X			X				4	2			X			engine failure, autorotated, during daylight
UH-2A					X					200	X		X		X			X				4	1		X				suspect rotor blade failure
UH-34D					X					100		X			X				X			5	4			X			collided with wires above a river

TABLE XXXVII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. NAVY HELICOPTER FATAL ACCIDENTS, 1965

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
SH-3A					X					unk	X				X							3	3		unknown				lost at sea, no witnesses, no survivors
SH-34J					X					300		X	X	X					X		X	5	5		X				unable to reduce power, suspect material malfunction
UH-2A					X					0	X				X			X				4	2			X	X		flew into water at night during rain showers
UH-34D					X					unk	X					X		X				4	4		unknown				lost at sea, midair collision
Second Aircraft																						4	4		unknown				
SH-34J				X						75		X			X			X				4	3	1		X			engine failure
UH-34G					X					200		X		X		X			X	X		2	2						midair collision, nonsurvivable
SH-3A				X						150	X		X		X				X			4	2		X				lost directional control
UH-34D						X				200		X	X	X					X		X	4	2	2	X				engine clutch failure
UH-34D					X					100		X		X				X			X	10	2				X	X	classified, no other details
UH-34D					X				X	2500		X	X		X			X				4	1			X			engine failure, autorotated to water

TABLE XXXVIII

DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF
U.S. NAVY HELICOPTER CRITICAL INJURY ACCIDENTS, 1964

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
UH-34D						X				0		X		X					X		X	3		2			X	X	lost rotor rpm

TABLE XXXIX

ESTIMATED CONDITION OF HELICOPTER AT ONSET OF EMERGENCY IN ESCAPE SITUATION ACCIDENTS, U. S. NAVY, 1961-1965

Helicopter Type	Nature of Emergency	Altitude Feet	Airspeed Knots	Attitude
HR2S-1	disintegrated in flight	600	-	level, then rolled
SH-34G	loss of control	600	-	level, then rolled
OH-34D	entered IFR conditions, pilot disorientation	4,200	unknown	unknown
SH-3A	fire in flight	3,500	unknown	level
UH-2A	rotor blade failure	1,200	unknown	level
CH-37C	lost tail rotor in flight	200+	unknown	level, then yawed
UH-34D	midair collision	400	-	yawed and rolled
UH-2A	suspect rotor blade failure	200	-	level
SH-34J	unable to reduce power	300	-	level
SH-3A	loss of directional control	150	hover	level with yaw
UH-34D	engine clutch failure	200	95	nose up
HSS-1N	throttle stuck open	800	120	autorotation, pitchup

APPENDIX II

TABULAR HELICOPTER ACCIDENT DATA, U.S. ARMY, 1958-1965

TABLE XL
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1958-1965

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	1,242,761	416	3.3	52	0.42	171	1.38	-	3	0.02	4	0.03
H-13	1,185,159	645	5.4	30	0.25	40	0.34	-	1	0.008	1	0.008
H-19	507,275	151	3.0	5	0.10	13	0.26	-	-	-	-	-
CH-21	477,642	266	5.6	20	0.42	64	1.34	3	-	-	-	-
H-23	1,326,718	448	3.7	14	0.11	23	0.17	-	1	0.008	1	0.008
H-34	707,730	164	2.3	15	0.21	38	0.54	-	-	-	-	-
H-37	102,189	32	3.1	3	0.29	11	1.08	-	-	-	-	-
CH-47	34,621	17	4.9	3	0.87	6	1.73	-	-	-	-	-
CH-54	1,122	-	-	-	-	-	-	-	-	-	-	-
TH-55	18,916	4	2.1	-	-	-	-	-	-	-	-	-
H-40	**	1	-	-	-	-	-	-	-	-	-	-
H-41	**	1	-	-	-	-	-	-	-	-	-	-
4A	**	2	-	-	-	-	-	-	-	-	-	-
5A	**	2	-	1	-	1	-	-	-	-	-	-
6A	**	1	-	-	-	-	-	-	-	-	-	-
Total or Average	5,604,133	2,150	3.8	143	0.26	367	0.65	3	5	0.009	6	0.01

* Number per 10,000 flying hours
** No time recorded

TABLE XLI
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1958

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	30	-	-	-	-	-	-	-	-	-	-	-
H-13	139,146	108	7.8	4	0.29	6	0.43	-	-	-	-	-
H-19	45,696	27	5.9	2	0.44	7	1.54	-	-	-	-	-
CH-21	73,391	52	7.1	3	0.41	12	1.64	-	-	-	-	-
H-23	105,641	55	5.2	1	0.095	2	0.19	-	-	-	-	-
H-34	87,096	45	5.2	-	-	-	-	-	-	-	-	-
H-37	6,164	3	4.9	-	-	-	-	-	-	-	-	-
CH-47	-	-	-	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	457,164	290	6.3	10	0.21	27	0.59	-	-	-	-	-

* Number per 10,000 flying hours

TABLE XLII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1959

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	3,492	2	5.7	-	-	-	-	-	-	-	-	-
H-13	144,764	95	6.6	3	0.21	3	0.21	-	-	-	-	-
H-19	52,061	22	4.2	-	-	-	-	-	-	-	-	-
CH-21	69,032	44	6.4	4	0.58	8	1.16	-	-	-	-	-
H-23	116,094	48	4.1	2	0.17	5	0.43	-	-	-	-	-
H-34	104,195	31	3.0	3	0.29	7	0.67	-	-	-	-	-
H-37	10,384	3	2.9	-	-	-	-	-	-	-	-	-
CH-47	-	-	-	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	**	1	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	500,022	246	4.9	12	0.24	23	0.46	-	-	-	-	-

* Number per 10,000 flying hours
** No time recorded

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A STUDY OF HELICOPTER ACCIDENT DATA TO DETERMINE THE FEASIBILIT--ETC(U)
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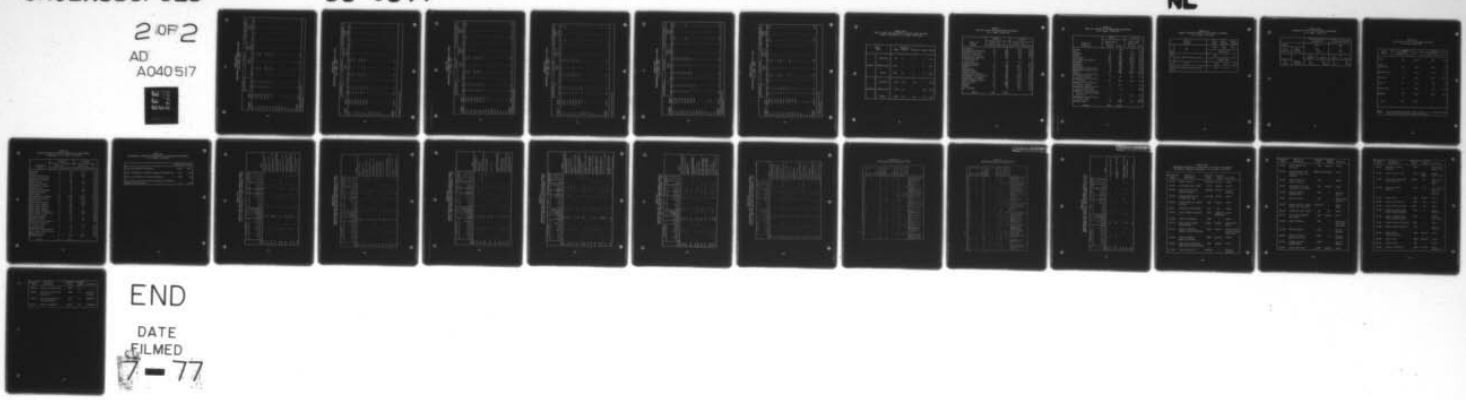

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TABLE XLIII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1960

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	15,763	15	9.5	-	-	-	-	-	-	-	-	-
H-13	154,066	91	5.9	4	0.26	6	0.39	-	-	-	-	-
H-19	62,267	26	4.2	1	0.16	1	0.16	-	-	-	-	-
CH-21	68,596	22	3.2	-	-	-	-	-	-	-	-	-
H-23	129,146	46	3.6	1	0.007	2	0.155	-	-	-	-	-
H-34	112,212	18	1.6	2	0.18	4	0.35	-	-	-	-	-
H-37	14,165	3	2.1	1	0.71	5	3.53	-	-	-	-	-
CH-47	-	-	-	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	**	1	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	556,215	222	4.0	9	.16	18	0.32	-	-	-	-	-

* Number per 10,000 flying hours
** No time recorded

TABLE XLIV
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1961

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	42,034	24	5.7	4	0.95	13	3.09	-	-	-	-	-
H-13	115,746	87	7.5	3	0.26	4	0.35	-	-	-	-	-
H-19	58,890	18	3.0	-	-	-	-	-	-	-	-	-
CH-21	74,336	35	4.7	2	0.27	8	1.08	-	-	-	-	-
H-23	112,926	34	3.0	2	0.18	2	0.18	-	-	-	-	-
H-34	103,201	13	1.3	3	0.29	13	1.26	-	-	-	-	-
H-37	14,185	3	2.1	-	-	-	-	-	-	-	-	-
CH-47	-	-	-	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	521,318	214	4.1	14	0.27	40	0.77	-	-	-	-	-

* Number per 10,000 flying hours

TABLE XLV
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1962

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	70,995	24	3.4	1	0.14	1	0.14	-	1	0.14	1	0.14
H-13	173,091	95	5.5	5	0.29	7	0.40	-	-	-	-	-
H-19	65,537	17	2.6	-	-	-	-	-	-	-	-	-
CH-21	68,020	35	5.1	3	0.44	13	1.91	3	-	-	-	-
H-23	163,497	62	3.8	1	0.06	1	0.06	-	-	-	-	-
H-34	97,735	20	2.0	1	0.10	3	0.31	-	-	-	-	-
H-37	12,704	6	4.7	-	-	-	-	-	-	-	-	-
CH-47	81	-	-	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	651,660	259	4.0	11	0.17	25	0.38	3	1	0.02	1	0.02

* Number per 10,000 flying hours

TABLE XLVI
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1963

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	161,266	60	3.7	6	0.37	12	0.74	-	-	-	-	-
H-13	140,177	63	4.5	3	0.21	3	0.21	-	1	0.07	1	0.07
H-19	57,178	18	3.1	1	0.18	2	0.35	-	-	-	-	-
CH-21	63,402	51	8.0	3	0.47	10	1.6	-	-	-	-	-
H-23	209,160	78	3.7	1	0.05	1	0.05	-	-	-	-	-
H-34	82,548	17	2.1	3	0.36	7	0.85	-	-	-	-	-
H-37	16,613	7	4.2	1	0.6	2	1.2	-	-	-	-	-
CH-47	3,382	5	14.8	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	733,726	299	4.1	18	0.25	37	0.50	-	1	-	1	-

* Number per 10,000 flying hours

TABLE XLVII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1964

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	355,942	129	3.6	16	0.45	48	1.35	-	1	0.03	2	0.06
H-13	136,498	50	3.7	3	0.22	3	0.22	-	-	-	-	-
H-19	77,328	15	1.9	1	0.13	3	0.39	-	-	-	-	-
CH-21	36,199	17	4.7	2	0.55	7	1.94	-	-	-	-	-
H-23	224,884	52	2.3	3	0.13	7	0.31	-	1	0.04	1	0.04
H-34	64,286	15	2.3	3	0.47	4	0.62	-	-	-	-	-
H-37	16,006	6	3.7	1	0.62	4	2.5	-	-	-	-	-
CH-47	10,992	5	4.5	-	-	-	-	-	-	-	-	-
CH-54	-	-	-	-	-	-	-	-	-	-	-	-
TH-55	-	-	-	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	**	1	-	-	-	-	-	-	-	-	-	-
5A	**	2	-	1	-	1	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-	-	-	-
Total or Average	922,136	292	3.2	30	0.33	77	0.84	-	2	0.02	3	0.03

* Number per 10,000 flying hours
** No time recorded

TABLE XLVIII
HELICOPTER ACCIDENT SUMMARY BY TYPE, U.S. ARMY, 1965

Helicopter Type	Flying Hours	All Accidents		Fatal Accidents					Critical Injury Accidents			
		Number	Rate*	Number	Rate*	Number of Fatalities	Rate*	Number of Critical Injuries	Number	Rate*	Number of Critical Injuries	Rate*
UH-1	593,239	162	2.7	25	0.42	97	1.63	-	1	0.02	1	0.02
H-13	145,671	56	3.8	5	0.34	8	0.55	-	-	-	-	-
H-19	79,326	8	1.0	-	-	-	-	-	-	-	-	-
CH-21	24,666	10	4.1	3	1.22	6	2.43	-	-	-	-	-
H-23	265,370	73	2.8	3	0.11	3	0.11	-	-	-	-	-
H-34	56,457	5	0.9	-	-	-	-	-	-	-	-	-
H-37	11,967	1	0.8	-	-	-	-	-	-	-	-	-
CH-47	20,166	7	3.5	3	1.49	6	2.98	-	-	-	-	-
CH-54	1,122	-	-	-	-	-	-	-	-	-	-	-
TH-55	18,916	4	2.1	-	-	-	-	-	-	-	-	-
H-40	-	-	-	-	-	-	-	-	-	-	-	-
H-41	-	-	-	-	-	-	-	-	-	-	-	-
4A	**	1	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-	-	-	-
6A	**	1	-	-	-	-	-	-	-	-	-	-
Total or Average	1,216,900	328	2.7	39	0.32	120	0.99	-	1	0.008	1	0.008

* Number per 10,000 flying hours
** No time recorded

TABLE XLIX
TYPE OF DUTY OF HELICOPTERS IN FATAL AND CRITICAL INJURY ACCIDENTS, U. S. ARMY, 1958-1965

Duty Class		Army	National Guard	Reserve	Other	Total
Number	Training	30	3	1	-	34
	Operational	109	1	-	4	113
	Total	139	4	1	4	148
Percent	Training	20.3	2.0	0.7	-	23.0
	Operational	73.7	0.7	-	2.6	77.0
	Total	94.0	2.7	0.7	2.6	100

TABLE L
TYPE OF FLIGHT IN HELICOPTER ACCIDENTS,
U. S. ARMY, 1958-1965

Type of Flight	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Training	1	12	0.7	0.6
Proficiency Training	13	365	8.8	17.0
Student Training	6	258	4.0	12.0
Tactical Training	5	103	3.4	4.8
Transition Training	5	165	3.4	7.7
Maneuver/Field Training	3	34	2.0	1.6
Other Training	-	15	-	0.7
Administrative	21	336	14.2	15.6
Ferry	4	42	2.7	2.0
Evacuation	4	29	2.7	1.3
Demonstration	2	47	1.3	2.1
Search and Rescue	3	34	2.0	1.6
Transport of Personnel	25	247	16.9	11.5
Transport of Cargo	4	47	2.7	2.1
Other Administrative	5	66	3.4	3.1
Test Flight	7	128	4.7	6.0
Combat	38	204	25.7	9.5
Other	1	11	0.7	0.5
No Listing	1	7	0.7	0.3
Total	148	2150		

TABLE LI
PHASE OF OPERATION IN HELICOPTER ACCIDENTS,
U. S. ARMY, 1958-1965

Phase of Operation	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Static	-	70	-	3.3
Taxi	2	57	1.3	2.7
Takeoff	1	71	0.7	3.3
Climb	11	153	7.4	7.1
In Flight	60	241	40.5	11.2
In Flight Low Level	17	89	11.5	4.1
Approach	10	188	6.8	8.7
Landing	5	204	3.4	9.5
Go-Around	5	50	3.4	2.3
Emergency Autorotation	4	39	2.7	1.8
Simulated Autorotation	1	134	0.7	6.2
Hover	15	291	10.1	13.5
Emergency Autorotation During Takeoff	2	57	1.3	2.7
Emergency Autorotation In Flight	10	212	6.8	9.9
Emergency Autorotation During Landing	-	37	-	1.7
Emergency Autorotation During Go-Around	-	4	-	0.2
Emergency Autorotation During Simulated Autorotation	1	7	0.7	0.3
Emergency Autorotation During Hover	-	8	-	0.4
Undetermined	4	238	2.7	11.1
Total	148	2150		

TABLE LII
DAMAGE CLASSIFICATION OF HELICOPTER ACCIDENTS,
U. S. ARMY, 1958-1965

Damage Class		Total Loss	Major Damage	Minor Damage
Number	All	648	1203	299
		Total 2150		
	Fatal and Critical Injury	142	6	-
		Total 148		
Percent	All	30.0	56.0	14.0
	Fatal and Critical Injury	96.0	4.0	-

TABLE LIII
INCIDENCE OF FIRE IN HELICOPTER ACCIDENTS,
U. S. ARMY, 1958-1965

		Total Helicopter Accidents		Fatal and Critical Injury Accidents	
Number		2150		148	
Fire Involved	Number	228		91	
	Percent	10.6		61.5	
Inception of Fire		In Flight	Impact	In Flight	Impact
	Number	27	201	11	80
	Percent	11.8	88.2	12.1	87.9

TABLE LIV
CAUSE FACTORS IN HELICOPTER ACCIDENTS,
U. S. ARMY, 1958-1965

Cause Factor	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Pilot	94	1624	38.1	47.4
Other Personnel	41	334	16.6	9.8
Maintenance	9	110	3.6	3.2
Material	52	675	21.1	19.7
Design	9	69	3.6	2.0
Facilities	8	224	3.2	6.5
Weather	34	392	13.8	11.4
Total	247	3428	-	-

Note: All contributing causes are listed; i.e., multiple cause factors were present in some accidents.

TABLE LV

IDENTIFICATION OF SYSTEMS INVOLVED IN HELICOPTER ACCIDENTS, U. S. ARMY, 1958-1965

Helicopter System	Number		Percent	
	Fatal and Critical Injury	All	Fatal and Critical Injury	All
Airframe	2	23	3.9	3.4
Brakes	-	3	-	0.5
Flight Controls	5	50	9.6	7.4
Seats and Canopies	-	7	-	1.0
Electrical System	-	11	-	1.6
Fuel System	5	20	9.6	3.0
Hydraulic System	-	7	-	1.0
Instrument System	-	3	-	0.5
Landing Gear	-	37	-	5.5
Auxiliary Equipment	1	5	1.9	0.7
Engine Controls	-	7	-	1.0
Oil System	-	4	-	0.6
Reciprocating Engine	14	239	27.0	35.4
Turboshaft Engine	5	79	9.6	11.7
Transmission	1	19	1.9	2.8
Main Rotor Blades	3	6	5.8	0.9
Main Rotor System	5	19	9.6	2.8
Tail Rotor Blades	-	23	-	3.4
Tail Rotor System	-	9	-	1.3
Tail Rotor Gearbox	1	24	1.9	3.6
Tail Rotor Drive Shaft	1	17	1.9	2.5
Tail Rotor Guard	-	2	-	0.3
Cooling System	-	3	-	0.5
Clutch Failure	1	12	1.9	1.8
Carburetor Air Filter	-	6	-	0.9
Shoulder Harness - Inertia Reel	1	2	1.9	0.3
Sling Release	-	8	-	1.2
Main Rotor Power Train	-	2	-	0.3
Tail Rotor Power Train	-	5	-	0.7
Weapons System	-	1	-	0.1
Undetermined	7	22	13.5	3.3
Total	52	675		

TABLE LVI

INCIDENCE OF SYSTEM MALFUNCTIONS IN HELICOPTER ACCIDENTS, U. S. ARMY, 1958-1965

	Number	Percent
Total Helicopter Accidents	2150	100
Total Accidents Involving System Malfunctions	675	31.4
Fatal and Critical Injury Accidents	148	6.9
Fatal and Critical Injury Accidents Involving System Malfunctions	52	35.1

TABLE LVII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1958

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
H-13E					X					100-				X								2	2						hit wires, bad weather, nonsurvivable
H-13E			X							100-				X								1	1						hit wires, incapacitated, nonsurvivable
H-13E					X					150/ 450				X					X			2	2		X				power loss due to lean mixture and erratic descent
H-13H					X					100-				X				X				1	1						low altitude, no witnesses or survivors, engine failure from icing, nonsurvivable
H-19C					X					450				X					X			3	3		X				collision with wires
H-19C					X					0				X				X			X	4	4			X			during IFR conditions, flew into ground
H-21C							X			100-				X					X			3	1			X			IFR conditions, disoriented and flew into ground
H-21C					X					100-				X					X		X	3	3			X			both aircraft in same flight, IFR conditions, disoriented, flew into ground
					X					100-				X					X		X	3	3			X			
H-21C							X			0				X				X			X	5	5			X			bad weather, night, continued VFR, flew into ground
H-23D					X					22				X					X		X	2	2			X	X		collision with wires

TABLE LVIII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1959

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
H-13G					X					150/200			X	X					X			1	1		X				lost fore and aft cyclic control
H-13G		X								100-				X				X				2	1				X		poor takeoff technique, struck trees
H-13H				X						100-				X					X		X	1	1				X	X	night hover, disorientation, struck trees
H-21C					X					100-				X					X		X	4	4				X	X	bad weather, disorientation, flew into ground
H-21C				X						100-				X				X				4	1				X		collided with mountain, victim not wearing hardhat
H-21C					X			X		200					X			X				7	2			X	X		power loss, autorotated to water, broke up and sank
H-21C						X				200				X				X				15	1				X		did not maintain airspeed, hit trees, under control
H-23B			X							150/200			X	X					X		X	2	2		X				failure of stabilizer spar
H-23D					X					400			X	X					X		X	3	3		X				cyclic control loss in flight, material failure undetermined
H-34					X					125					X				X			4	4		X				collision with wires, water impact
H-34A								X		50			X	X					X		X	3	1					X	clutch failure in flare during autorotation
H-34A					X					unk			X	X				X			X	2	2				X	X	power loss, hit trees, exploded, impacted and burned

TABLE LIX
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1960

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
H-13E					X					0				X				X				2	2						bad weather, flew into ground, nonsurvivable
H-13G					X					100				X					X		X	2	1		X				power settling in rearward flight
H-13H					X					100-				X					X			1	1		u n k n o w n				at low altitude, hit projecting tree, nonsurvivable
H-19D					X					175			X	X				X			X	3	1			X	X		power loss, rotor rpm lost, crashed, burned
H-23D					X					650						X			X			1	1			X			midair collision
					X					650						X			X		X	1	1				X		
H-34C	X									0							X	X				2	1						hit wires during taxi, pilot struck by blade, nonsurvivable injury
H-34C					X					unk				X				X			X	3	3						disoriented, flew into ground, nonsurvivable
H-37A					X					unk			X	X				X			X	5	5						disoriented, flew into ground at night, nonsurvivable
H-13E					X					100-				X					X			2	2						skid caught wires, aircraft impacted out of control, nonsurvivable

TABLE LX
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1961

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
UH-1A					X			X		100+			X	X					X	X		7	2					X	tail rotor gearbox failed during attempted autorotation
UH-1A					X					1000			X	X					X	X		3	3		X				main rotor system failure
UH-1A							X			0				X					X			4	4						hit rocks on approach, non-survivable
UH-1A					X					0				X				X		X		4	4						disoriented, flew into mountain, nonsurvivable
H-13E					X					100-			X	X					X			2	1				X		power loss, collided with trees, fatality due to inhalation of gasoline and/or fumes
H-13H			X							100-				X					X	X		1	1				X	X	collided with wires
H-13H					X					25			X	X					X	X		2	2				X		litter support failure, collided with trees
H-21C					X					0				X					X			3	1				X		bad weather, disoriented, flew into trees, landed inverted
H-21C					X					400			X	X					X	X		7	7		X				unknown material failure, broke up in air
H-23D					X					500			X	X					X			1	1		X				unknown control or power loss at 500 feet, aircraft fell in from 100 feet
H-23D					X					200			X	X					X	X		1	1		X				main rotor assembly separated from aircraft in flight
H-34C			X							100/ 150				X					X			6	6		X				misuse of controls in bad weather
H-34C					X					250				X					X	X		6	6		X				maintenance error allowed main rotor blades to hit and sever tail pylon
H-34C									X	100-				X					X	X		8	1				X	X	pilot used improper technique

TABLE LXI
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1962

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
UH-1A					X					1300				X					X			6	1		X				improper use of flight controls
H-13E					X					30				X					X		X	1	1				X		following road, struck wires
H-13G					X					100-				X					X		X	2	2						collided with wires, nonsurvivable
H-13H									X	300				X					X		X	1	1		X				control system malfunction due to maintenance error, became inverted in air
H-13H					X					70				X					X		X	2	2				X		collided with wires
H-21C								X		1450			X	X				X				3	2	1			X		power loss, autorotated into trees
H-21C					X					900			X	X					X		X	3	3		X				maintenance-induced material malfunction, flight controls
H-21C					X					400			X	X					X		X	10	8	2	X				flight control loss caused aircraft to become inverted in flight
H-23D					X					34				X					X		X	1	1				X		collided with wires
H-34C			X							150			X	X					X		X	3	3		X				fuel system malfunction
H-13E					X					600/ 750				X					X			1	1		X				cause unknown, possibly pilot fatigue

TABLE LXII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1963

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
UH-1B				X			X			100-												3	1		unknown				hit by enemy small arms fire at 5 feet and flipped on right side
UH-1B					X					105				X					X		X	5	3		X				collided with wires at 105 feet
UH-1B				X						100-				X					X			3	2						crashed lifting sling load, nonsurvivable, fatalities due to flying debris and impact
UH-1B					X					500				X					X	X		2	2		X				severe weather, broke up in air
UH-1B						X				100-				X					X			3	1		unknown				combat, no details
UH-1B						X				200					X			X				4	3			X			night landing, disorientation, hit water, drowned after exit from aircraft
H-13G			X							200			X	X					X		X	1	1		X				power loss, carburetor malfunction
H-13H							X			0				X				X			X	2	1					X	poor landing technique, unsuitable terrain
H-13H			X							170				X					X		X	1	1		X				aircraft inverted in flight, cause unknown
H-19D					X					1000			X	X					X		X	2	2		X				aircraft broke up in air, maintenance error caused clutch failure
H-21C					X					100+			X	X					X			7	7		X				suspect control failure
H-21C			X							100-				X					X			9	1				X		could not gain altitude, 3500 feet above mean sea level, settled in 100-foot trees
H-21C					X					unk				X					X			unk	2		unknown				aft rotor failure due to small arms fire, no other details
H-23D					X					50					X				X		X	2	1			X			collided with wires and impacted in lake, sank
H-34C					X					unk				X					X		X	1	1						flew into mountain in bad weather, nonsurvivable
H-34C		X								65			X		X			X				15	1				X		power failure, impacted, rolled over in shallow water, fatality due to inhalation of gasoline
H-34C			X						X	1200			X	X				X			X	13	5					X	autorotated after engine failed during climbout
H-37B				X						1500				X				X			X	2	2		X				small arms fire at 1500 feet, dropped sling load, then crashed and burned

TABLE LXIII
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1964

Model	Phase of Operations								Altitude in Feet	Disarmed	Disembarked	Material Failure	Impact					Fire		Personnel			Survivability Requirements			Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff																	
													Ground	Water	Aircraft	Other	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
H-13E					X					35			X				X	X		1	1						collided with wires, burst into flames, dead before impact, nonsurvivable
UH-1A					X					100		X	X				X			7	1		X				suspected fuel system malfunction
UH-1B					X					100-				X		X			X	2	2						crashed into trees in fog, non-survivable
UH-1B								X		200			X				X		X	4	4		X				lost rpm, tried autorotation
UH-1B								X		100				X		X			X	4	2			X			misuse of controls in flight, 2 drownings
UH-1B							X			unk			X				X		X	4	4		unknown				received small arms fire, will not be investigated
UH-1B					X					2000		X	X				X		X	12	12		X				tail boom failure in flight, bodies thrown out during descent
UH-1B					X					500		X	X				X	X		6	6		X				engine malfunction and main rotor blade assembly separated in air
UH-1B					X					unk										unk	2		unknown				combat, no details, no investigation
UH-1B	X									unk			X				X		X	unk	2		unknown				combat, no details, no investigation
UH-1B					X					unk									X	unk	1		unknown				combat, hit by ground fire, no other details
H-13G					X					250			X	X			X			1	1		X				lost main rotor control in flight
H-13G					X					180			X	X			X		X	1	1		X				power loss
H-21C						X				100-			X	X			X			13	1				X		power loss, lap belt failed at impact
H-21C					X					0			X				X			6	6						disorientation, flew into ground, nonsurvivable
H-23D						X				300					X		X		X	2	2		X				midair collision, main rotor separated, aircraft fell 300 feet
						X				300					X		X			1	1		X				midair collision, lost tail boom
H-34C								X		800			X	X			X		X	4	1					X	power loss, autorotated to hard landing
H-34C	X									0			X				X			2	1				X		ground resonance in taxi, rolled over, lap belt failed
H-19D					X					1500			X	X			X			3	3		X				failure of rotor blade horizontal hinge pin
H-23D					X					100+				X			X			2	2		X				rolled on side and broke up in the air
H-34C					X			X		1000			X	X			X		X	3	2					X	power loss, autorotated to a hard landing
H-37B									X	100-			X	X			X		X	4	4				X		power loss on approach with sling load
UH-1B							X			55			X				X		X	9	3				X		lost rotor rpm in clouds, collided with trees
UH-1B					X					unk									X	4	4		unknown				enemy fire, tail boom exploded, no other details
UH-1B					X			X		250			X	X			X	X		5	1				X		power loss, attempted auto-rotation, landed in trees and descended vertically to ground
UH-1B					X			X		200			X	X			X			3	1				X		power loss, autorotated to hard landing, lap belt failed
UH-1B					X					100-				X			X			X	2	1				X		flew into ground
UH-1B					X															X	2	2		unknown				combat, shot down, no other details
H-23B						X				500				X			X			X	2	2		X				cartwheeled twice, became inverted in flight, main rotor separated at 50 feet
SA					X					5500			X	X				X	X		2	1						control failure, rotor blade killed copilot in air, nonsurvivable, pilot bailed out

TABLE LXIV
DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER FATAL ACCIDENTS, 1965

Model	Phase of Operations: Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff	Altitude in Feet	Endurance	Disemmarked	Material Failure	Impact: Ground	Water	Aircraft	Other	Controlled	Uncontrolled	Fire: In-Flight	Post Crash	Personnel: Occupants	Fatalities	Critical Injuries	Survivability Requirements: Escape	Emergency Flotation	Impact Protection	Fire Protection	Comment
H-13E					X					100-					X				X			2	2						collided with wires, broke up, impacted water, sank, nonsurvivable
H-13H					X					75				X					X		X	1	1						disoriented due to weather, hit inverted, nonsurvivable
H-13H					X					100-				X				X			X	2	1					X	passenger trapped by impact, burned fatally
H-13S					X					unk											X	2	2		unknown				combat, no altitude, no other details
H-13S					X					unk			X		X							2	2		unknown				undetermined material failure, hard impact with water, fatalities from drowning
H-21C					X					100+						X		X		X		3	3						nonsurvivable, wing of F-105 struck cockpit killing pilot and copilot
H-21C					X					0				X					X		X	2	2						very hard landing, nonsurvivable
H-21C						X				0				X				X		X		4	1			X			low landing approach and fuel starvation
H-23D					X					600			X	X					X		X	1	1		X				maintenance-induced control failure
H-23D					X					400				X					X		X	1	1		X				weather, disorientation, crashed inverted into trees
H-23G					X					50				X					X		X	1	1						collided with wires, killed by electrical shock, nonsurvivable
H-47A						X				150			X	X					X	X		3	1		X				in-flight fire
UH-1A								X		300				X				X			X	2	2				X		autorotated and struck trees
UH-1A					X					unk			X	X					X		X	2	2		unknown				main rotor blade failure, altitude details unknown
UH-1B					X					100-				X					X		X	5	3				X		collided with wires
UH-1B										unk												2	1		unknown				combat, no details, will not be investigated
UH-1B	X									100-				X					X		X	4	1					X	crewchief pinned in wreckage, burns fatal
UH-1B										unk												unk	2		unknown				combat, no details, not investigated
UH-1B					X					0				X				X				2	1				X		marginal weather, flew into mountain at 2400 feet
UH-1B								X		75						X		X			X	7	6				X	X	midair collision
UH-1B	X									75						X		X			X	4	4				X	X	midair collision
UH-1B										unk												unk	1		unknown				combat, no details, not investigated
UH-1B						X				0				X				X			X	4	4				X		marginal weather, flew into ground on approach
UH-1B					X					100-				X				X		X	X	4	1		unknown				enemy small arms fire, hit hard, 3 crew thrown out, 1 crew missing
UH-1B					X					unk				X					X	X		unk	2		unknown				enemy fire, 2 fatalities, not investigated
UH-1B					X					150				X					X	X		unk	1		X				enemy small arms fire, lost control at 150 feet, number of occupants unknown
UH-1B										unk										X		4	4		unknown				combat, no details, no survivors, not investigated
UH-1B	X									100-				X					X			12	3				X		lost rotor rpm on takeoff, rolled over
UH-1B					X					unk										X		unk	2		unknown				combat, blew up in air, no other details, number of occupants unknown
UH-1B					X				X	200+			X	X					X		X	12	12		X				undetermined power loss, attempted autorotation, then rotor blades severed tail boom
UH-1B		X							X	150			X	X				X			X	4	4		X				power loss at 150 feet, attempted autorotation, fell in from 50 feet
UH-1B										unk				X						X		4	4		unknown				combat, all crew missing, no other details, not investigated
UH-1B					X					4000			X	X					X		X	4	4		X				lost main rotor in flight
UH-1D										unk												unk	2		unknown				landing assault, exploded and burned, *2 crew missing, number of occupants unknown*
UH-1D					X					100+						X			X		X	8	8		X				midair collision
UH-1D					X					100+						X			X		X	10	10		X				midair collision
UH-1D					X					100				X					X	X		1	1						weather, disorientation, rotor blade entered cockpit, fireball in air, nonsurvivable
UH-1D					X					200						X			X	X		5	5						midair collision, nonsurvivable
UH-1D					X					200						X			X	X		4	4						
UH-1D								X		100-				X				X			X	5	3					X	flew into ground 200 feet short and 100 feet below pad, rolled over, disorientation
OH-6A					X					150				X				X				3	2						pilot distracted, flew into ground, nonsurvivable
CH-47A					X					600			X	X					X		X	3	3		X				lost blade in flight

TABLE LXV

DESCRIPTION AND SURVIVAL REQUIREMENTS SUMMARY OF U.S. ARMY HELICOPTER CRITICAL INJURY ACCIDENTS, 1962-1965

Model	Phase of Operations									Altitude in Feet	Embarked	Disembarked	Material Failure	Impact						Fire		Personnel			Survivability Requirements				Comment
	Taxi	Takeoff	Climbout	Hover	In-Flight	Approach	Landing	Autorotation	Waveoff					Ground	Water	Aircraft	Other	Controlled	Uncontrolled	In-Flight	Post Crash	Occupants	Fatalities	Critical Injuries	Escape	Emergency Flotation	Impact Protection	Fire Protection	
1962																													
UH-1B					X					100-				X					X			9	1			X		low altitude, hit trees, broke up
1963																													
H-13E					X					120					X				X			1	1					hit wires, injured at wire impact, unavoidable
1964																													
HU-1B						X				50				X					X	X		6	2			X		combat, tail pylon on fire prior to impact with ground
H-23D								X		300			X	X				X				2	1			X		hard landing from autorotation
1965																													
UH-1B					X					1500				X					X			4	1	X				combat, lost tail rotor

TABLE LXVI

ESTIMATED CONDITION OF HELICOPTER AT ONSET OF EMERGENCY IN ESCAPE SITUATION ACCIDENTS, U. S. ARMY, 1958-1965

Helicopter Type	Nature of Emergency	Altitude Feet	Airspeed Knots	Attitude
H-13E	power failure	150-450	cruise	level
H-13C	collision with wires	450	cruise	level
H-13G	lost fore and aft cyclic control	150-200	cruise	out of control
H-23B	fatigue failure of stabilizer spar	150-200	cruise	level
H-23D	cyclic control system failure	400	cruise	level
H-34	collision with wires	125	80	level
H-13G	rotor blade tip stall	100	rearward, excessive	level
H-13H	midair collision	650	-	level
UH-1A	main rotor system malfunction	1,000	normal	descending turn
H-21C	loss of control, blades struck fuselage	400	cruise	nose pitched up and right, then down
H-23D	power failure, loss of control	500	cruise	level
H-23D	main rotor assembly separated from aircraft	200	cruise	level
H-34C	loss of control	100-150	-	out of control

Helicopter Type	Nature of Emergency	Altitude Feet	Airspeed Knots	Attitude
H-34C	rotor blades hit aircraft	250	cruise	level
UH-1A	severe buffet followed by loss of control	800-1,300	normal	climb
H-13H	loss of bolt in cyclic system	300	-	stall
H-21C	push-pull rod disconnected in flight	900	cruise	level
H-21C	flight control malfunction	400	-	pitchup stall
H-34C	power failure	150	-	level after takeoff
H-13E	power failure, rotor blades hit aircraft	600-750	-	stall, spin
UH-1B	collision with wires	105	70	level
UH-1B	fire and explosion in flight	500	cruise	level
H-13G	power failure	200	-	stall during takeoff climb
H-13H	power failure	170	-	out of control
H-19D	clutch failure, broke up in air	1,000	-	out of control
H-21C	flight control malfunction	100+	-	out of control
H-37B	small arms fire	1,500	cruise	level

Helicopter Type	Nature of Emergency	Altitude Feet	Airspeed Knots	Attitude
UH-1A	possible engine failure	100	-	nose down, right bank
UH-1B	loss of rotor rpm	200	high speed	level, gunnery run
UH-1B	tail boom separated from aircraft	2,000	65	nose low, turn to left
H-13G	loss of flight control	250	30	nose down to the left, out of control
H-13G	power loss	180	cruise	level
H-23D	midair collision	300	40	level
H-19D	rotor blade failure	1,500	80	level
H-23D	flight control problem (undetermined)	100	-	uncontrolled
H-23B	loss of flight control (undetermined)	500	-	slight left bank
H-23D	flight control failure	600	-	level
H-23D	pilot disorientation	400	-	out of control
H-47A	power loss, in-flight fire	150	cruise	level
UH-1B	power loss	200+	cruise	level
UH-1B	engine fire	150	-	climb
UH-1D	midair collision	100+	cruise	level formation

Helicopter Type	Nature of Emergency	Altitude Feet	Airspeed Knots	Attitude
CH-47A	loss of rotor blade	600	85	-
UH-1B	in-flight fire and explosion	500	-	out of control
UH-1B	hit by enemy fire, in-flight fire	150	-	descent
UH-1B	loss of control	4,000	95	climbout